TRANSACTIONS

OF

THE AMERICAN SOCIETY

OF

HEATING AND VENTILATING ENGINEERS

VOL. XIV.

FOURTEENTH ANNUAL MEETING
NEW YORK, JANUARY 21-23, 1908

SUMMER MEETING
NIAGARA FALLS, N. Y., JULY 24-25, 1908

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THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

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CLXXXIV.

THE AMERICAN SOCIETY

OF

HEATING AND VENTILATING ENGINEERS.

FOURTEENTH ANNUAL MEETING.

New York City, N. Y., January 21, 22, 23, 1908.

PROCEEDINGS.

FIRST DAY—AFTERNOON SESSION.

(Tuesday, January 21, 1908.)

The meeting was called to order by Mr. C. B. J. Snyder, President, at 2.45 P.M.

President Snyder: The Secretary will please call the roll, and the members will answer to their names as called.

Secretary Mackay: Before calling the roll I announce the following candidates elected to membership during the year:

Frank E. Baker	Member.
Francis N. Bard	"
Albert C. Burdick	"
P. C. Doherty	"
George D. Farnham	"
Howard T. Gates	"
William A. Green	"
Laurent Lowenberg	"
Frederick F. MacNichol	"

Frederick R. Perkins	Member.
Arthur G. Pettelkow	"
Charles S. Prizer	"
Daniel G. Rice	"
Loring G. Robbins	"
George T. Simpson	"
George L. Greenman	Associate.
Daniel Hogan	Junior.
Roy E. Lynd	"
Benjamin Natkin	"
George W. Nichols	"
Samuel C. Parter	"

Secretary Mackay called the roll of members and announced the presence of a quorum.

President Snyder: We will now have the reading of the minutes of the previous meeting.

Mr. Chew moved that the reading of the minutes be dispensed with, as the printed proceedings will be distributed later. Carried.

President Snyder then read his address, as follows:

PRESIDENT'S ADDRESS.

Custom, rather than the constitution under which this Society is organized, sanctions your President in presenting in an annual address a general review of the progress of the Society and of the work in which we are engaged.

The general review of the Society I shall make very brief, since particular mention as to membership and finances will be presented by the Board of Governors and the appropriate committees.

This Society was organized in 1895 by but a handful of men against the advice of fellow engineers and others who contended that it was not possible that there existed the opportunity for the establishment of another engineering society. The result, however, has been quite the reverse, for the membership now numbers nearly three hundred and fifty, of which quite a percentage are in foreign countries.

The finances are sound, having been gone over very thor-

oughly and found correct by an auditing committee appointed for the purpose.

The business of the Society, however, cannot, unfortunately, be transacted in the interval between the regular meetings with the proper thoroughness—from a representative standpoint—because of the fact that the membership of the Board of Governors is and should be selected from widely separate sections of the country. This renders frequent meetings impossible, while those that are held must partake largely of the emergency type, when careful, thoughtful consideration of matters is impossible.

The remedy for this does not seem to me to be quite clear. The few upon whom the work devolves justly resent the situation, realizing that if the Society is to continue to advance and hold its place among the sister engineering societies that the actual formation and governing work should be continually vivified by the addition of new blood, and that some method must be found whereby the Board of Governors may become a governing body in fact as well as in name.

It may well be that the only method by which this can be accomplished will be through the Society defraying the actual expenses of those who, living far distant, yet should attend certain of the meetings of that board.

Interest in the welfare of the Society must be intensified and broadened or there will be no progress.

This leads quite naturally to the point raised again and again by your presiding officers: the diffidence, or indifference or actual laziness, call it what you will, of our members in the preparation of papers for the stated meetings of the Society.

The point of argument has been passed quite some time since.

Every member is of that higher order of intelligence which readily receives and proceeds along the lines of cause and effect.

Time and again in private conversation members give every evidence of the ability to present something of the utmost interest to all, but when the matter is put fairly up to them they seem to wither and dry up,—a most dangerous malady, as it were, one needing strong corrective measures.

The hesitation of many men in presenting papers seems to be due to the entirely mistaken idea that a paper to be acceptable and interesting must be replete with geometric formulas, graphic illustrations and numerous original diagrams.

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This is all wrong.

The lack of proper papers endangers the well-being of the Society.

The remedy is that the Publication Committee should be vested with the same plenary powers as are bestowed upon the editor of a newspaper—the power to name the member and the subject upon which he is to submit a paper.

This power should properly reside in this committee, as it alone is responsible for the publications of the Society.

The great success attending the semi-annual meeting held in Milwaukee, Wis., should set at rest the question raised each year as to the advisability of holding them at points somewhat distant from New York.

The enthusiasm of our Western members and their close attention to the meetings are very encouraging, and give great promise for the increase of membership by those more recently brought within the sphere of influence of the work of the Society.

This is the age of education—specialized technical education —the one-thing-best-one-man age, and is growing more intensely so every day.

The heating and ventilating engineer has a highly specialized work to perform, and to accomplish this thoroughly and creditably he must not only possess a knowledge of the laws of mechanics, but of physics as well; in fact, this latter must really be placed first if the engineer desires to obtain and hold a high position in his chosen profession.

He must understand most thoroughly the laws governing the generation of heat, the effects of temperature and of humidity, and of the effects of both pure and vitiated air upon the human body.

This is necessary before he can bring into play his knowledge of mechanics, the designing of a boiler or furnace which will accomplish a certain result with a minimum consumption of fuel, the transmission of heat to its place of use, the control of the movement of air by mechanical means, and all of the multitude of details of the work which usually are regarded as first when really they are last.

A complete and thorough understanding of these apparently dissimilar and unrelated subjects is absolutely necessary to the

proper solution of any problem in heating and ventilation, especially if there be also included the possible appearance before a board of managers having in charge the erection of a building in which such a plant should be installed, and who are not thoroughly posted as to why such should be considered as necessary now when it was not required when they were young—arguments which you have all heard and which it is unnecessary to repeat.

A point often overlooked, however, is that our rapid increase in the density of population of the cities has given rise to entirely new conditions which cannot be met by the continuance of old methods.

Members of school boards often forget that not only has this the effect of restricting the light and air for all classes of buildings in our large cities, towns and villages, but that there is also a most radical change in the curriculum of our schools, whereby the large general schoolroom with its limited attendance and the few recitation rooms are no longer in use.

Instead, practically the entire school day of a child is spent in one room, and the former class of fifteen or twenty has now grown to one of forty and perhaps sixty pupils.

Uniform heating and artificial ventilation, both designed upon sound scientific principles, therefore become necessities.

The question of humidity in the air supply to buildings under artificial ventilation has been too often side-tracked as not being really essential.

Its importance, however, is now being more clearly understood by both engineers and their clients, and as soon as the mechanical difficulties in the way can be thoroughly and effectually removed, engineers will no longer hesitate in insisting that it be also included in all installations.

The invention and introduction of numerous new mechanical appliances or devices, together with the rapid improvement of many of the older ones, until they no longer present the old familiar appearance, has fostered the impression among many owners that the tendency was towards the design and introduction of new and complicated devices and that no longer was the standard of simplicity, ease and economy in operation considered by the designing engineer.

In some cases which have come under my observation, I think

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there is some ground for this impression; but, on the other hand, I have found that changed conditions have created new requirements, such in fact, that the plant in which simplicity was the chief merit in design would be utterly incapable of filling.

This tendency towards complications or multiplication of parts in any heating or ventilating plant is one to be carefully avoided, as most unfortunately the chances are that in its operation and maintenance the genius of its designer will no longer play any part whatsoever and what the owner doesn't understand and his operating engineer, perhaps, cannot see or will not or cannot give a good reason for, is apt to be most heartily condemned by both.

It is thus to the advantage of the designer to carefully follow up or take an interest in securing a good operating engineer to whom the plant may be first entrusted until its worth has been fully proven.

The legislation advocated by this Society, following the lead set by the State of Massachusetts, whereby better sanitary conditions are sought to be obtained in the public buildings of various States, has already borne most satisfactory results, and no effort should be spared to obtain similar enactments by the legislatures of every State in the Union.

I most heartily congratulate the members upon the work already accomplished and trust that in the meeting now before us there will be a united effort to broaden and extend the scope and influence of the Society by observation, experiment and research, presenting the results thereof in brief, simple form for the consideration and information of all.

Secretary Mackay then read his report, as follows:

SECRETARY'S REPORT.

New York, January 21, 1908.

The American Society of Heating and Ventilating Engineers:

Gentlemen: Your Secretary would report a large increase in membership during the past year.

At the last annual meeting our membership was composed of 1 Honorary member, 247 Members, 20 Associates, and 11 Juniors, or a total of 279 members of all grades.

During the year we have added 31 members, 8 Associates and

9 Juniors to our roll. One member was reinstated, 1 Associate and 3 Junior members have been advanced to full membership, 3 members have resigned, and 2 members have been dropped from the roll for non-payment of dues. Our present membership is, 1 Honorary member, 278 members, 27 Associates, and 17 Juniors, or a total of 323 members of all grades—a net increase of 44.

The financial affairs of the Society are in a good condition. At the last annual meeting there was a balance in the hands of the Treasurer of $1,794.90. We have received from all sources during the past year $3,912.41, which, with the balance on hand, made a total of $5,707.31 available.

The total expenditures amounted to $3,662.45, leaving a balance in the hands of the Treasurer of $2,044.86.

There is owing to the Society from members for dues, etc., and from newly elected members for initiation and dues, $915.00, this with the balance on hand amounts to $2,959.86.

All bills have been paid except those in connection with this meeting.

The members dropped from the roll during the past year owed the Society $60.00.

The 1906 Proceedings have been edited and printed, and will be forwarded to the members as soon after this meeting as they can be received from the binders.

The 1907 Proceedings have been edited and will be placed in the printer's hands in the next thirty days, in the hope that they may be forwarded to the members before the summer meeting. In connection with the Proceedings, I would mention that we have been very much hampered by not receiving the corrected discussion from the members, we are waiting for two members to return their discussion from the last annual meeting sent out in August and seven members to return their discussion from the summer meeting sent out in October. This delay in addition to delaying the Proceedings has compelled the ordering of an additional copy of the stenographer's notes, so that in the event of an unnecessary delay or failure to return the corrected discussion on the part of any member, the editor will endeavor to furnish it from the uncorrected copy.

The Secretary's expenses for the year, including stenographer, clerk hire, rent of post-office box, certificates, pin badges, ex-

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penses in connection with the summer meeting, electrotypes, postage, expressage, telephone calls, office rent, etc., amounted to $1,190.98.

The Society held a summer meeting at Milwaukee, Wis., July 18th and 19th, which was successful in every way.

Your Secretary sent out over one thousand letters to the members requesting papers and topics for discussion at this meeting, also a number of special letters to individual members at the request of the Board of Governors; papers were promised by some who were unable to find time to prepare them, those that were received and accepted were printed and forwarded to the members, others will be read from manuscript. The reports of two important committees were printed for consideration at this meeting.

Respectfully submitted,

WM. M. MACKAY,

Secretary.

Treasurer Scollay then read the following report:

TREASURER'S REPORT.

January 21, 1908.

Balance on hand, January 22, 1907		$1,794.90
Cash received:		
Dues	$2,802.28	
Initiation fees	670.00	
Pin badges	28.50	
Electrotypes	109.50	
Proceedings and papers	265.00	
Interest on deposits	37.13	3,912.41
		$5.707.31
Disbursements:		
J. J. Little & Co., 1905 printing	$993.75	
Schoen & Kellerman, printing and stationery	253.94	
W. M. Mackay, Secretary's account	1,190.98	
W. M. Mackay, Secretary's salary	500.00	$2,938.67
Carried forward		$2,938.67

Brought forward		$2,938.67
Bormay & Co., electrotypes	$213.25	
Harold Godfrey, reporting annual meeting	100.00	
George H. Lambert, reporting summer meeting	115.40	
Wm. Kent, editing 1906 Proceedings	125.00	
United Engineering Societies Meeting Room	75.00	
Expenses at annual dinner	45.90	
D. Williams Co., electrotypes	11.55	
Poates Engraving Co., electrotypes	11.00	
Ehrman Mfg. Co., number buttons, etc.	8.60	
People's Trust Co., refund money order	10.15	
Empire State Surety Co., Treasurer's bond	6.00	
People's Trust Co., collections	1.93—	3,662.45
Treasurer's balance on hand		$2,044.86

Respectfully submitted,

U. G. SCOLLAY.

On motion the report was received and placed on file.

Mr. James Mackay, Vice-Chairman of the Board of Governors, read the following report:

REPORT OF THE BOARD OF GOVERNORS.

New York, January 21, 1908.

The American Society of Heating and Ventilating Engineers:

Gentlemen: Your Board of Governors met and organized on January 24, 1907, appointing committees on Finance, Membership and Publication, and an Executive Committee.

The various committees have given careful attention to their duties, and the Board has met as often as was found necessary during the year.

An Auditing Committee was appointed to examine the Treasurer's accounts, which were found correct. This committee made

a full and complete report, making a number of recommendations, all of which have had careful consideration and proper action by the Board of Governors.

A successful summer meeting was held at Milwaukee, Wis., July 18 and 19, 1907, which fully confirmed the judgment of your Board that it will be in the interest of the Society and its membership to hold the summer meetings in the West, which enables many of our Western members who are unable to attend our annual meetings to attend, and take part in these summer meetings, increasing their interest in the Society, and increasing our membership in the section in which the meeting is held.

Your Board have investigated the desirability of the Society acquiring membership in the National Fire Protective Association, and would recommend that the By-Laws be so amended as to permit of the Society holding membership in this and other kindred associations which will be beneficial to our Society.

Mr. Charles W. Newton, of Baltimore, Md., a pioneer heating and ventilating engineer and a Charter Member of this Society, having retired from active practice, on the recommendation of the membership of the Society in Baltimore, your Board would unanimously recommend that he be made an Honorary Member of the Society at this meeting.

There is a growing demand for back volumes of our Proceedings from colleges, libraries and from our members. Volume I is almost exhausted. We have the following number of volumes on hand:

Volume	I,	1895	Proceedings..	9	volumes.
"	II,	1896	" ..	32	"
"	III,	1897	" ..	127	"
"	IV,	1898	" ..	147	"
"	V,	1899	" ..	119	"
"	VI,	1900	" ..	123	"
"	VII,	1901	" ..	147	"
"	VIII,	1902	" ..	108	"
"	IX,	1903	" ..	160	"
"	X,	1904	" ..	150	"
"	XI,	1905	" ..	168	"

a total of 1,290 volumes, which at our regular members' price is valued at $6,450.00, or at their special price, $4,837.50.

Volume XII will be issued during February, Volume XIII by July. This will bring our Proceedings up to date. These Proceedings are sold to our members at a stated price with a reduction if six or more volumes are purchased at one time. We have a cut cabinet in which are kept the electrotypes which have been used in our volumes. These would be available in the event of deciding to reproduce any of the volumes.

We have on hand 12 solid gold and 12 gold-plated pin badges.

The Society has no office furniture or fixtures of its own, those it is using being furnished by the Secretary.

Respectfully submitted,

C. B. J. SNYDER, Chairman,
JAMES MACKAY, Vice-Chairman,
WM. G. SNOW,
FRANK K. CHEW,
R. C. CARPENTER,
ALBERT B. FRANKLIN,
E. F. CAPRON,
R. E. ATKINSON,
W. M. MACKAY, Secretary.

On motion the report was accepted.

REPORTS OF STANDING COMMITTEES.

Secretary Mackay read the following communication from Mr. James D. Hoffman, Chairman of the Committee on Tests:

LAFAYETTE, IND., January 15, 1908.

MR. W. M. MACKAY,
Secretary, American Society of Heating and Ventilating Engineers, New York.

My dear Mr. Mackay: I find it will be impossible to be present with you at the meeting next week. Am truly sorry, too, for I know you will not only have a good meeting, but you will have a good time as well.

We are nearing the close of the first semester, which entails considerable work, and then we have some special heating and power tests to come off the following week, and these require extra superintendence, so there will be no chance this year.

Concerning the report of our committee, would say that Mr.

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Widdicombe and I corresponded a number of times along some lines that we had in mind, but as yet the data are not in any shape to give in a report.

I have the promise of considerable material along the line of tests of different forms of coils and radiator transmission efficiencies, but the subject is not complete enough to present.

Assuring you again of my chagrin at not being able to do my part in the work, and begging you to understand that if my own personal desires could be realized I would be with you at the meeting, I am, with personal regards to yourself,

Very truly yours,

J. D. HOFFMAN.

Secretary Mackay read the following communication from Chairman T. J. Waters:

REPORT OF THE COMMITTEE ON COMPULSORY LEGISLATION.

CHICAGO, January 10, 1908.

MR. W. M. MACKAY,

Secretary, American Society of Heating and Ventilating Engineers, New York City.

Dear Sir: Replying to yours of the 19th ult., in which you advise me that as Chairman of the Committee on Compulsory Legislation of our Society I will be expected to submit a report of progress at our next annual meeting, I wish to advise you that during my incumbency as President of the Illinois Chapter of the A. S. of H. & V. E. I appointed a committee which worked strenuously during the fall and winter of 1906 and 1907 in having a bill prepared with a view of having the same passed at the meeting of the State Legislature of Illinois. The bill was entitled "An Act to provide for the proper sanitation, lighting, ventilating, heating and protection from fire of public buildings, and to provide a penalty for violation thereof."

In this bill provision was made for at least fifteen square feet of floor space and two hundred cubic feet of air space for each occupant to be accommodated in each room used for an assemblage of ten or more persons, also for the supplying of at least thirty cubic feet of pure air per minute for each person.

A provision was also made for at least eight square feet of floor space and two hundred cubic feet of air space, and for the supply-

ing of at least thirty cubic feet of pure air per minute for each occupant in an audience room, theatre or hall.

These requirements were understood to refer to a system employing mechanical means for removing foul and supplying fresh air, and it was stated that the requirement of thirty cubic feet per minute per occupant was to be enforced only when a difference of thirty degrees or more existed between the temperature of the room to be ventilated and external atmosphere.

Stress was laid upon the provision that the apparatus was to be so installed as to prevent an uncomfortable draft, the inside temperature to be maintained with seventy degrees Fahr. in any weather and without greater difference at any two points on the breathing plane, in occupied portion of the rooms, than three degrees.

In the ventilation of boiler, engine, pump, heater or tank rooms these were to be provided with doors or shafts, fans or other means of ventilation where a temperature of 90 degrees Fahr. or greater was to be contended with, and the bill provides means to change the atmosphere not less than once every ten minutes in order to prevent the rising of the temperature of the entering air above 120 degrees Fahr., also to provide the proper quantity of fresh air at the same time.

The use of wooden flues or air ducts for heating and ventilating apparatus was prohibited and proper protection was to be provided in the form of guards or casings about combustible materials.

This bill when it becomes a law will cover the same points and form a part of similar acts in the States of Massachusetts, Act of 1902; New Jersey, Act revised 1903; New York, 1904, and Pennsylvania 1905, and the only reason for it being held over until the next meeting of the General Assembly was on account of late date of its reading.

I wish to assure the Society that the members of the Illinois Chapter will work unceasingly and with united effort to have such a bill as is above outlined passed at the next meeting of our Legislature, January, 1909, and the writer sincerely hopes that we may be successful in accomplishing our purpose.

Very respectfully,

T. J. WATERS,

Chairman, Committee on Compulsory Legislation.

Secretary Mackay: I have received a copy of a letter from another member of the committee, Mr. W. H. Bryan, addressed to Mr. Waters.

St. Louis, Mo., January 11, 1908.

Mr. T. J. Waters,

710 Tribune Building, Chicago, Ill.

Dear Sir: Your valued favor of 10th inst. at hand enclosing copy of your report as Chairman of the Committee on Compulsory Legislation. Same seems to cover the ground very well, and I have no further suggestions to make. I presume the Committee has not been called together for the reason that there seemed to be no special work which they could do just now, there being little or no agitation at this time. No movement of this kind is under way in Missouri so far as I know, and the time hardly seems ripe to begin one. However, this is an important committee, and I have no doubt it will render valuable service. You may of course count upon me for any committee work that may develop. Am sending a copy of this letter to the Secretary as suggested.

With continued regards, I am,

Very truly yours,

William H. Bryan.

President Snyder. You have heard the report. Are there any remarks? They are to be congratulated upon having pushed this matter to the point they have, and I am sure we wish them success.

TELLERS.

President Snyder appointed as tellers Homer Addams, of Allentown, and Samuel Kauffman, of St. Louis.

NEW BUSINESS.

Mr. Franklin: The Board of Governors have assigned to me a very pleasant duty, and that is, to commend to your consideration the name of Charles W. Newton, as an honorary member. The Society at the present time has but one honorary member.

I look back to the beginning of my life as a heating engineer, when I was privileged to be associated with Mr. Newton, and I

found him a man full of experience and knowledge, and what was a wonderful thing I had never met in other men, he was always ready to impart to me everything that he knew. Any problem that came up he was more than glad to explain why he would do it that way. It afforded me great pleasure to be associated with him, and I owe him a great debt. And so, gentlemen, it is a great pleasure and privilege to place before you for honorary membership, the name of Mr. Charles W. Newton, recommended by the Board of Governors.

I move, Mr. President, that Professor Carpenter be authorized to cast one ballot for the Society, for the election of Charles W. Newton as an honorary member. I ask for unanimous consent.

Which, being duly seconded, was unanimously agreed to.

As authorized, Professor Carpenter cast one ballot for Charles W. Newton, as an honorary member, and the President announced the result.

Mr. Chew: I think there are some here to-day who do not know that on the charter papers of this Society Mr. Newton figures as our President. He was once President of the Society, although his modesty would not allow him to serve a full term. He, nevertheless, made it possible for this body to be chartered according to law.

Further than that, he was interested in his work. He has assisted wherever he could, and has supported many of the members when their applications were handed in for membership in this body.

He has, also, been identified with some of the most notable hot-water heating work ever done anywhere—certainly in the United States. And when we honor a man of that character we certainly do credit to ourselves.

And further, Mr. Franklin has told you that in a generous measure he possessed the information of the advanced engineers when Mr. Franklin was a young man, and was willing to help others, which, I think, is a further credit because in those early days men were not as generously disposed to impart their information as we now find them, not only in our own Society, but in all fields of mechanical engineering.

President Snyder: In the report of the Secretary he mentioned the delay in returning discussions, which entails upon the Society an unwarranted expense, to say nothing of the delay. I think

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it would be in order for some one to make a motion that the Publication Committee be instructed not to wait longer than thirty days for the return of any such matter, and if not returned that the committee be instructed to proceed with the Proceedings with the data at hand. We cannot afford to wait for our Proceedings.

After some discussion Professor Carpenter made such a motion, and Mr. Franklin moved to amend, so as to make the time sixty days. Carried as amended.

Some discussion took place in regard to the delay of the reports of special committees, but no action was taken.

Mr. Franklin: In the President's address is the matter of giving the Publication Committee sufficient power to call upon members—to name a member and the subject on which he is to submit a paper. The President and the Board have found some difficulty in getting the members to prepare papers. As your President has well said in his paper there seems to be a diffidence or actual reluctance. This Society should have the benefit of the members preparing papers on subjects that they are capable of preparing them on. It has been thought by the Board of Governors that this committee should be given the power mentioned in the President's address—that it should be vested with the same plenary powers as are bestowed upon the editor of a paper, the power to name a member and the subject upon which he is to submit a paper.

I move that the Publication Committee be given the power as indicated in the President's address ..

The motion was seconded, and after some discussion was agreed to.

THE ILLINOIS CHAPTER.

Mr. Hale, Secretary of the Chapter: We do not want to put ourselves in the foreground, but we believe we are accomplishing something for ourselves. This Society has two meetings a year, one in January and one in July, while the Chapter has one every month from October to May. We have had a number of papers which were very interesting, and which will probably be submitted to this Society for consideration.

The Illinois Chapter is well into its second year, and wishes to report an unusual interest in its meetings and prospects for a very profitable season.

The annual election of the Chapter was held on October 14, 1907, the officers elected being as follows:

JAMES MACKAY, President,
GEO. MEHRING, Vice-President,
JOHN F. HALE, Secretary,
AUGUST KEHM, Treasurer.

BOARD OF GOVERNORS.

EDMUND F. CARON,
SAMUEL R. LEWIS,
THOS. J. WATERS.

All of our meetings are held in the rooms of the Western Society of Engineers, where we have the use of the reading-room containing an extensive engineering library and magazines of today, also, the meeting-room with a capacity of 150 persons.

The first meeting after election was addressed by Mr. L. Bruch, who gave a very interesting illustrated talk on the manufacture of cast-iron radiators and boilers. The second half of the evening was spent in the discussion of "hot water under forced circulation."

The second meeting of the Chapter was held on Monday evening, December 9, 1907, the subject being "Smoke Prevention," the speaker of the evening being Mr. Paul P. Bird, Chief of the Smoke Department of the City of Chicago.

On the evening of January 13, 1908, the Chapter was addressed by Mr. J. J. Houlihan, Chief Boiler Inspector for the City of Chicago, and his talk led to much discussion regarding the formula for figuring safety valves, also the tendency to increase the tensile strength of steel for tubular and fire-box boilers where a reduction in thickness was desirable.

A special committee appointed by the President was present at a number of smoke tests in the city schools as well as several factory plants where the approved form of setting according to the city regulations was compared with other methods, both calculated to eliminate the smoke evil, a subject close to a Chicagoan heart, on account of the nature of the coal close at hand and the necessity of using this in preference to coal containing less volatile matter.

XUM

Our committee reports a number of tests they now have in preparation, the results of which will be submitted to this Society in due time.

Our meetings have been very well attended, and we feel that the establishment of Chapters in other States will be of the greatest benefit to the parent body, in the fact that it brings the members together more frequently and maintains an interest in the Society affairs that is not always possible where the meetings are held but twice a year.

The proceedings of our various meetings will be fully reported to the Secretary of the Society, and will in all probability find their way into the Society's records.

We wish to extend an invitation to all of those contemplating Chapters in various States to visit us, and it may be possible that they may be able to profit by the experience we have just been through.

Mr. Donnelly: I want to inquire whether any action has been taken in regard to what a member may use to designate his membership in the body. I think members should put on their cards such designation so that it can be seen they are members of this Society.

Secretary Mackay: I can only say many of the members now use the lettering on their letter heads—"Member of the American Society of Heating and Ventilating Engineers." Mr. Donnelly has suggested that we get a miniature of the Society's emblem or something of that sort and furnish it to the members, but nothing has been done.

Mr. Donnelly: I move the Board of Governors prepare such designation, something which will authorize them to use certain lettering or certain emblem, and request the members to use it.

The motion was duly seconded, and was agreed to.

On motion the session adjourned.

First Day—Evening Session.

(Tuesday, January 21, 1908.)

The convention was called to order at 8.20 P.M. by President Snyder.

President Snyder: We will first hear the report of the tellers.

The tellers presented the following report:

NEW YORK, January 21, 1908.

Your tellers beg to report the following result after tabulating votes for officers from 150 members qualified to vote.

President.

Jas. Mackay.....116
T. J. Waters..... 28

1st Vice-President.

Jas. D. Hoffman..... 99
Geo. H. Mehring..... 44

2d Vice-President.

B. F. Stangland..... 90
J. J. Blackmore..... 50

Secretary.

Wm. Mackay.....131
Hugh J. Barron..... 12

Treasurer.

U. G. Scollay.....112
L. J. Wing..... 29

Board of Governors.

C. B. J. Snyder.....118
R. C. Carpenter.....129
W. Nelson Haden..... 60
August Kehm..... 69
Frank K. Chew.....107
B. S. Harrison..... 53
J. H. Brady..... 39
Bert C. Davis..... 37
Jno. F. Hale..... 65
W. H. McKiever..... 44

Respectfully subscribed,

HOMER ADDAMS,
THOS. BARWICK,
SAM KAUFFMAN,
Tellers.

We will now take up the report of the Committee to Collect Data on Fan Blast Heating.

Mr. William G. Snow, Chairman, presented a report of progress.

After a long discussion the matter was laid over, for the Committee to bring in a report at the next meeting.

On motion the session adjourned.

Second Day—Afternoon Session.

(Wednesday, January 22, 1908.)

The convention was called to order at 2.15 P.M. by First Vice-President, Mr. James Mackay.

Vice-President Mackay: The first paper on the programme is "The Transmission of Heat Through Radiator Surfaces at Various Temperatures," by John B. Allen. Mr. Allen is not here, and we thought it best to hold the paper in abeyance a little while until he arrives. We will take up the report of the Committee to Collect Data on Hot-water Heating for Residences.

Mr. E. F. Capron read a preliminary report, which, after considerable discussion, was laid over.

Mr. Quay: I move that a committee of three or five be appointed to take up the question of heating surface of house-heating boilers and report at the next meeting.

The motion was duly seconded and agreed to.

Vice-President James Mackay: We will take up the paper "The Transmission of Heat Through Radiator Surfaces at Various Temperatures," by John R. Allen. Professor Kent will read the paper.

The paper was read by Professor Kent, and was discussed by Messrs. Cary and Chew. It was then laid over for further discussion at the summer meeting.

Vice-President Mackay: We will pass to a paper on "The Austrian Coefficient for the Transmission of Heat Through Building Materials," by Mr. W. W. Macon.

Mr. Macon read the paper. It was discussed by Messrs. Cary and Kent.

Vice-President Mackay: We will now take up Topic No. 1, "The Additional Amount of Radiation Seeming Advantageous for Warming Rooms Exposed to the Strongest Wind Effect."

The topic was discussed by Vice-President Mackay and Messrs. Chew, Witten, Cary and Franklin.

Mr. Chew (addressing President-elect James Mackay): I have been deputized by Mr. Thompson, of the International Correspondence School, to bestow upon the newly elected President these volumes, dealing with the technology of heat and a lot of other things. A set of these books has been given to each of our Presidents for a number of years back, and I think we can appreciate them as an honor to the Society, coming from such an educational institution as his. These, you can see, are no small gift, and are well worth being received and appreciated. The gift consists of a set of text-books of the International Correspondence School of Scranton, Pa.

The speaker here handed a set of technical books to Mr. Mackay. (Applause.)

President-elect Mackay: I thank Mr. Thompson, of the International Correspondence School, for his valuable present which will be highly appreciated.

After some announcements the meeting adjourned until Thursday morning, at 10.30 o'clock.

Third Day—Morning Session.

(Thursday, January 23, 1908.)

The convention was called to order by President Snyder, at 10.45 A.M.

President Snyder: The first part of the programme is "Relative Corrosion of Wrought Iron and Soft Steel Pipes," by T. N. Thomson.

Mr. Thomson read the paper, which was discussed by Messrs. Cary, Carpenter, Kent, Donnelly, Barwick, Barron and Speller.

Mr. Quay: I desire to take this opportunity to refer to the untimely death of Mr. Theodore L. Webster, of the firm of Warren Webster & Co., of Camden, N. J., who was killed in a railroad accident in that city December 27th. We miss his genial presence, as he was always in attendance at our meetings, as well as was his brother, the two being inseparable. I move that condolences be sent to the widow of Theodore L. Webster.

The motion was duly seconded and agreed to.

XUM

President Snyder: I have received communications from various places which desire our mid-summer meeting, viz.: Buffalo, Chicago, Cincinnati, Cleveland, Columbus, Denver, Detroit, Duluth, Milwaukee, Niagara Falls, Seattle, Kansas, Indianapolis.

The various cities were called and the members expressed their preference.

The meeting adjourned until afternoon.

Third Day—Afternoon Session.

(Thursday, January 23, 1908.)

The convention was called to order at 2.30 P.M. by President Snyder.

President Snyder: The next paper will be the paper by Mr. Wing, entitled "Fuel Economy."

Mr. Wing read the paper, and it was discussed by Messrs. Kent and Cary.

A paper on "Air Washers" was then read by Mr. Weinshank, and discussed by Messrs. Kauffman, Cary, Kent and Barwick.

On motion the subject of air washers was referred to a committee to collect information.

President Snyder: We will proceed with the installation of officers.

(All the newly elected officers were escorted to the rostrum.)

President Snyder (addressing newly elected officers): Gentlemen, it becomes my pleasant duty to turn over to you the work of the Society for the coming year. I wish you every success. (Applause.)

(The gavel was presented to President-elect James Mackay, of Chicago.)

President Mackay: Gentlemen, members of the American Society of Heating and Ventilating Engineers, I appreciate highly the great honor you have conferred in electing me your presiding officer to occupy the chair so well filled by those splendid men who have been my predecessors. I feel a sense of gratitude for the success our Society has achieved. But we have more work before us, and it rests with you and the members of the Society as to what we make of it. Your officers are of your creation, to carry out your desires and wishes, and we bespeak your hearty

coöperation and ask that you individually do what you can to make the coming year and all other years a success. (Applause.)

(The remaining officers took their respective places.)

President Mackay: You now have before you the balance of the programme for the afternoon session.

Professor Kent then read a paper on "Testing and Rating House-heating Boilers."

After a brief discussion the paper was laid over and referred to the Committee on Standards.

BY-LAWS.

President Mackay stated that the Board of Governors had favorably considered the proposition of amending the By-Laws so as to provide that the Treasurer be a member of said Board.

Mr. Barron: I give notice I will offer such an amendment. It seems to me every officer should be a member of the Board.

Professor Kent: I do not see why the Secretary or other officer who is reëlected every year should be a perpetual member of the Board.

Mr. Chew: The recommendation was made by the Board that the Treasurer be made a member of the Board of Governors.

Mr. Snyder: It was decided it would be wise to lay it before the Society and let the Society decide what should be done.

Mr. Chew: I am not responsible for this recommendation; it was made by the Auditing Committee. They thought, after going over the business of the Society, it was a desirable thing to do.

Professor Kent: I would be glad to vote for Mr. Scollay for a director for three years, but I have known in other societies where officers were made *ex-officio* members by virtue of their holding office proved bad practice.

Professor Carpenter: I think I can explain this. The Treasurer had charge of the funds, and it happened that the Board needed some information which could not possibly be had unless he had been on the Board. He could have been of material advantage to the Board respecting the amount of money, disposal of the money and various things of that kind, and it seemed to me that the Treasurer could always be of assistance to the Board.

XUM

When this recommendation was brought to us by the Auditing Committee, which made a most careful audit of the books of the Society, all things seemed to point to the advantage of having the Treasurer on the Board. That is what led to the action. I appreciate thoroughly the dangers which follow from this *ex-officio* business. I know one society that has been water-logged simply because of that practice. But their practice is much more serious than our own—a man who has been President is always on the Board. As long as the men are elective officers we are not likely to be water-logged.

Secretary Mackay: When the Society was first organized, the President only of the elected officers was a member of the Board of Governors. The Treasurer was not then and never has been a member of the Board of Governors. On account of the fact that we occasionally elected a President from a distance from headquarters, where the meetings have to be held, the First Vice-President was allowed to represent the President at meetings of the Board, and finally in making some changes to the By-Laws they added the Second Vice-President to the Board. The Secretary has always been a member. So the Board is composed now of the President, First and Second Vice-Presidents, the five members you elect, and the Secretary. (The speaker read Art. VI., Sec. 5, relative to the composition of the Board, also Sec. 4, duties of the Treasurer.) The original incorporators of the Society felt the Treasurer should not be a member of the Board.

(Some further discussion on the subject ensued, but no action was taken by the meeting.)

Mr. Quay: I would suggest it might be wise to have a New York Chapter. I do not know whether any action has been taken. Our members have talked of having a Chapter in New York.

President Mackay: The way to get at that is for twelve New York members to make application to the Board.

Mr. Barwick: A great many questions coming up among the members could be taken up and discussed. We meet only once a year in New York, and very seldom any of us get so far as the Western cities when the summer meetings are on. I think there should be a Chapter in New York.

Mr. Chew: The question of a Chapter in New York is not altogether new. The summer the Illinois Chapter was gotten up we talked this matter over, and a meeting was called and the

members invited to attend and say something, but the responses discouraged the people who had the matter in charge.

President Mackay: It is purely a local matter.

Mr. Chew: I suggest one of the past Presidents be called upon to preside, so the new Board can withdraw and do its work while the discussion goes on.

(The suggestion was complied with, and Professor Kent was called to the chair, the Board withdrawing and meeting in an adjoining room in order to save time and enable the members to get away.)

(Professor Kent in the chair.)

Mr. Donnelly: I notice in the report of the summer meeting, a resolution respecting the scope of the Society and the manufacturers of certain apparatus making plans and specifications of their work was passed. I move that the question of manufacturers of heating apparatus making plans and specifications be referred to a special committee to consider the subject to find out the ideas of the officials of the Master Steam Fitters' Association and the trade in general, and report at the next meeting of the Society.

Mr. Quay: I think we should also take up the question relative to boiler manufacturers with the Master Steam Fitters' Association. But that can be taken up later.

Mr. Barron: There won't be any harm in getting a committee upon the subject.

Mr. Donnelly: It is a question of limiting the scope of the engineer. I think it should be left to his own discretion.

The motion was not seconded, and no action was taken.

On motion the meeting adjourned.

List of Members and Guests present at the Fourteenth Annual Meeting, January 21, 22, and 23, 1908:

MEMBERS.

Addams, Homer	Brennan, John S.	Cryer, T. B.
Andrus, N. P.	Capron, E. F.	Davis, James H.
Armagnac, A. S.	Carpenter, R. C.	Denny, Edward B.
Barr, Geo. W.	Cary, A. A.	Dick, Thos. M.
Barron, Hugh J.	Chew, Frank K.	Doherty, P. C.
Barwick, Thomas	Clark, Geo. W.	Donnelly, Jas. A.
Bradbury, C. R.	Corbett, Frank J.	Driscoll, Wm. H.

Dornheim, G. A.
Edgar, A. C.
England, Geo. B.
Farnham, Geo. D.
Feldman, A. M.
Franklin, A. B.
Gombers, H. B.
Graham, Jos. H.
Hale, John F.
Harvey, Andrew
Haskins, E. O.
Hemingway, Wm. S.
Hess, H. H.
Ingalls, Fred'k D. B.
Jellett, Stewart A.
Kauffman, Samuel
Kehm, August.
Kellogg, C. V.
Kenrick, A. E.
Kent, James M.
Kiewitz, Conway
Lisk, J. P.
Mackay, James
Mackay, W. M.
Mallory, H. C.
McArthur, Chas. D.
McCann, Frank G.
Mehring, Geo.
Martin, H. S.
Monash, Mark E.
O'Hanlon, George
Osbourn, M. P.
Payne, John A.
Pettelkow, A. G.
Rice, Daniel J.
Scollay, U. G.
Scott, Chas. E.
Sherman, L. B.
Snow, Wm. G.
Snyder, C. B. J.
Smith, F. W.
Stangland, B. F.
Stockwell, W. R.
Teran, Cesar
Thomson, T. N.
Vrooman, Wm. C.
Waggoner, E. P.
Webster, Warren
Weinshank, Theo.
Wing, L. J.
Wolfe, Wiltsie F.

GUESTS.

Aldous, Geo. S.
Allen, E. P.
Austin, W. E.
Bahr, E. L.
Barnes, L. K.
Black, J.
Braemer, W. G. R.
Brodnax, C. M.
Chenoweth, W. H., Jr.
Corboy, John A.
Danforth, M. E.
Downe, Geo. E.
Eckart, J. A.
Edwards, J. E.
Fay, Chas. H.
Fisk, E. C.
Fundinger, C. G.
Foster, Chas. K.
Gifford, Robt. L.
Hegg, Jas. E.
Hogan, J. E.
Hughes, Chas. S.
Hunt, R. B.
Koven, L. O.
Kragh, C. W.
Le Compte, W. G.
Macon, W. W.
Mahony, Frank
Marshall, A. B.
Mayo, Robt.
McLarty, John D.
McPherson, F. J.
Moore, L.
Morrison, Chas.
O'Neill, A. J.
Otis, G. E.
Otis, J. S.
Purdy, F. G.
Peterson, G.
Quackenboss, L. H.
Richard, P. M.
Sanford, L. O.
Seymour, C. H.
Sisson, C. W.
Stevens, F. H.
Stewart, D.
Stoughton, E. R.
Sutton, J. G.
Taylor, W. W.
Thompson, Walter
Van Buren, W.
Whitten, H. W.

PAPERS

OF THE

FOURTEENTH ANNUAL MEETING,

New York, January 21, 1908.

XUM

CLXXXV.

AUSTRIAN COEFFICIENTS FOR THE TRANSMISSION OF HEAT THROUGH BUILDING MATERIALS.

BY W. W. MACON.

(Non-member of the Society—presented by request.)

Feeling that the figures for the transmission of heat through building materials, as adopted by the Society of Austrian Engineers and Architects, might well be placed in the records of the American Society of Heating and Ventilating Engineers, especially as these figures allow for some interesting observations to be made in comparison with the present practice in this country, a translation was made of the published figures of that society, reducing them from the metric system to the English system here in use. It is understood they are based on tests made in connection with the heating and ventilation of the new stock exchange at Budapest.

The percentage increase or correction to be made for exposure or for the location of the rooms in a building is not so great as commonly employed in this country. For example, after the amount of transmitted heat is calculated for a given room an increase of 20 per cent. for a northern exposure is provided for, where it has been common to use as much as 25 in this country, and for east and west exposures the figures are increased by 15 per cent., whereas, a room with a western exposure is here subject to a factor increase of 25 per cent. and when on the east side of the building to one of 15 per cent., while a south room would have the calculation increased by, say, 5 per cent., where the Austrian figures do not allow for any increase for the southern exposure at all. In both Austria and this country 10 per cent. is added in all cases for inleakage of air.

XUM

The Austrian coefficients call for a further modification for lofty rooms or rooms over 4 meters (13.12 ft.) in height. Then the inside temperature is not taken as that at the breathing line, or head high as they call it, but is calculated as the mean between the head high temperature and the temperature at the ceiling. The ceiling temperature is said to be equal to

$$T' = T + 0.1\ T\ (H - 3)$$

T being the temperature head high in degrees Centigrade and H the room height in meters. This equation in English units is

$$t' = t + 0.03\ (t - 32)\ (h - 10)$$

t' and t being the temperatures at ceiling and head high, respectively, in degrees Fahrenheit, and h the room height in feet. Then the mean inside temperature for heat transmission calculations is $\frac{1}{2}\ (t' + t)$.

The figures are also interesting in that they serve as an example of the great refinement to which the foreign engineer is wont to go. It may be added that the transmission of heat through different types of floors and roofing is given, with a detail illustration of the type of floor and roof, and that the coefficients for transmission through concrete are included.

An accompanying table gives the value of transmission of heat through various kinds of outside wall; brick, stone and concrete.

TABLE I.

HEAT TRANSMISSION THROUGH BUILDING WALLS.

Number of British thermal units per square foot of surface per hour for 1 degree Fahr. difference in temperature on opposite sides.

	Brick.						Concrete.	
Thickness. Inches.	Plastered in and out.	Plastered Inside.	With 2-in. air space.	With 1-in. air space.	Sand-stone.	Lime-stone.	Ordinary.	With air space.
8	0.40	0.43	....	0.23	....	...	0.49	0.30
12	.31	.34	0.27	.19	0.58	0.64	.43	.28
16	.26	.29	.22	.17	.51	.56	.37	.26
20	.22	.24	.19	....	.45	.50	.33	.24
24	.19	.21	.17	....	.41	.45	.30	.22
28	.17	.18	.15	....	.37	.41	.27	.20
32	.15	.16	.13	....	.33	.36	.25	.19
36	.14	.14	.12	....	.31	.34	.23	.18
40	.13	.13	.11	....	.29	.32	.22	.17

It will be noted that the sandstone and limestone are subject to the greatest loss of heat, the limestone averaging about 10 per

cent. more than the sandstone; that ordinary concrete is the next greatest loser of heat; but that concrete with an air space is, for the ordinary thicknesses obtaining in building construction, a loser of less heat than ordinary brick walls. The singular thing in connection with a concrete wall with an air space is that while it loses less heat for the smaller thicknesses of wall, as compared with the same thicknesses of brick wall, it loses more heat in proportion than does the brick wall, as the thickness of wall is increased.

The figures published by the Austrian Society cover also brick walls with stone facing. It gives the coefficients for brickwork, 4, 10 and 20 inches in thickness with stone facing 5 to 40 inches thick, and the refinement is carried to such a degree that the coefficients for heat transmission are given for brick walls with a limestone facing and also with a sandstone facing. The figures given in the original table for a 4-inch brick wall with both limestone and sandstone are practically the same as the figures for a brick wall plastered inside and out. The values for a 10-inch brick wall with stone facing are a little greater than the brick walls.

A second table gives the heat transmission through partitions and inner walls. The original figures include those for partition

TABLE II.

HEAT TRANSMISSION THROUGH PARTITIONS AND INNER WALLS.

Number of British thermal units per square foot of surface per hour for 1 degree Fahr. difference in temperature on opposite sides.

Thickness. Inches.	Wood.	Wood plastered both sides.	Ordinary.*	Plaster construction.
¼	0.56			
½	.52			
¾	.44	.27		
1	.41	.24		
1¼	....	.21	.64	.62
2	....	....	.60	.59
2½	....	....	.56	.56
3	....	....	.52	.53
3½	....	....	.49	.50
4	....	....	.47	.47

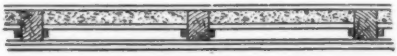
* Brick partition walls plastered about 10 per cent. less than outside plastered brick walls.

walls of brick, plastered, but these are not given in the table, as they are about 10 per cent. less than outside plastered brick walls, this being an indication of the fact that inside and outside brick walls are differentiated.

The values for various types of floors and roofing are as follows:

Plaster ceiling, planks, filling, double wood floor, 0.055 B. T. U. per degree difference.

Single wood floor, 0.33 B. T. U. per degree difference.

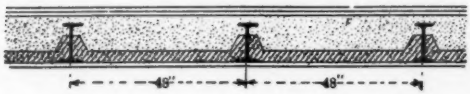


Plaster ceiling, air space, filling and soft wood floor, with cold air above, 0.1 B. T. U. per degree difference; with cold air under, 0.05 B. T. U. per degree difference.

Plaster ceiling, air space, filling and double floor, with cold air above, 0.088 B. T. U. per degree difference; with cold air under, 0.045 B. T. U. per degree difference.

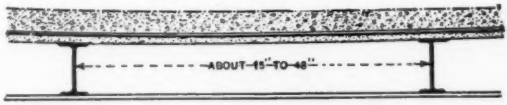
Reënforced concrete ceiling with double flooring, 024 B. T. U. per degree difference.

Reënforced concrete ceiling, with double flooring and plaster ceiling inclosing an air space, 0.187 B. T. U. per degree difference.



Reënforced concrete ceiling, with plaster expanded metal construction, concrete with expanded metal, filling and double flooring:

Beams.		Beams.	
6-inch.....	0.16 B. T. U. per degree difference.	10-inch.....	0.1 B. T. U. per degree difference.
7- "	.14 " " " " "	12- "	.09 " " " " "
8- "	.12 " " " " "	15- "	.08 " " " " "
9- "	.11 " " " " "	20- "	.07 " " " " "



Reënforced concrete roof, with plaster, inclosing an air space, cement with expanded metal reënforcing, asphalt and gravel covering, 0.2 B. T. U. per degree difference.

(To indicate the refinement in practice, it may be stated in this connection that figures are given for beams 6.3 inches in height to beams 21.7 inches, and for each of these different heights a value depending on the spans between the beams. The figures vary from 0.199 heat units for the case where the girder is 6.3 inches high and the span 48 inches to 0.202 for the case where the beam is 21.7 inches high and the span 32 inches.)

Reënforced concrete roof without air space, 0.57 B. T. U. per degree difference.

For tar paper roof over 1-inch boards, 0.436 B. T. U. per degree difference.

Zinc and copper roofing on 1-inch boards, 0.44 B. T. U. per degree difference.

Slate roofing on 1-inch boards, 0.43 B. T. U. per degree difference.

Tiling without boards, 0.99 B. T. U. per degree difference.

Corrugated iron without boards, 2.13 B. T. U. per degree difference.

WINDOWS AND SKYLIGHTS.

For single windows about ⅛-inch thick, 1.08 B. T. U. per degree difference.

Single windows about ¼-inch thick, 1.07 B. T. U. per degree difference.

Double windows, 0.47 B. T. U. per degree difference.

Wired glass, 1.04 B. T. U. per degree difference.

Single skylight, 1.14 B. T. U. per degree difference.

Double skylight, 0.48 B. T. U. per degree difference.

DOORS.

For doors, values are given for outside and inside doors, and for doors of soft and of hard wood. The coefficients are given in an accompanying table:

TABLE III.

HEAT TRANSMISSION THROUGH DOORS.

British thermal units per square foot of door per hour per degree difference in temperature on opposite sides of door.

Thickness. Inches.	Soft Wood.		Hard Wood.	
	Inner.	Outer.	Inner.	Outer.
1	0.46	0.49	0.60	0.69
1	.39	.42	.54	.63
1¼	.31	.33	.47	.53
2	.26	.28	.42	.46
2¼	.21	.23	.37	.41

DISCUSSION.

Professor Kent: I want to ask if you have any information about the amount of the difference in temperature at which these experiments were made. It may be the difference in temperature is much greater than those in Peclet's experiments.

Mr. Macon: I do not know anything about the differences. Nothing in the information I have says anything about it.

Professor Kent: The figures are surprising. As I remember the figures for a 16-inch wall, I think we have about 23 B. T. U. for 100 degrees difference in temperature, and this is 46. Former tables, based on Peclet's results, show 103 for plaster, for single windows, and, I think, most tables have it 120. I do not know where the increase came from, but this table gives it 195. This is a tremendous difference. We have had papers by Hauss of Belgium, and Jones of England, covering these points, and this is different from anything we have had yet.

Mr. Macon: I was surprised with the glass surface coefficient. I have talked with others, and they cannot give any reason why these figures should be so large. They feel that our old figures are about right for general practice in that country.

There is another consideration that affects the practice in countries abroad, and that is, it is practically impossible for them to get steam pressures much over one pound.

Mr. Cary: I notice that provision is made for concrete construction. That is becoming very common. There is more and more concrete construction going in every year, and it has come to stay. I think it would be well if the committee on hot-water heating is continued, for it to collect data on this subject and furnish us with the necessary coefficients for concrete. If the Austrian coefficients are so divergent from our own practice, we would like some information of our own.

Professor Kent: It is time that new experiments were made on heat transmission through walls, etc., under American conditions. I have placed on the blackboard a sketch of an apparatus I have proposed for making such experiments. (See Fig. 1.)

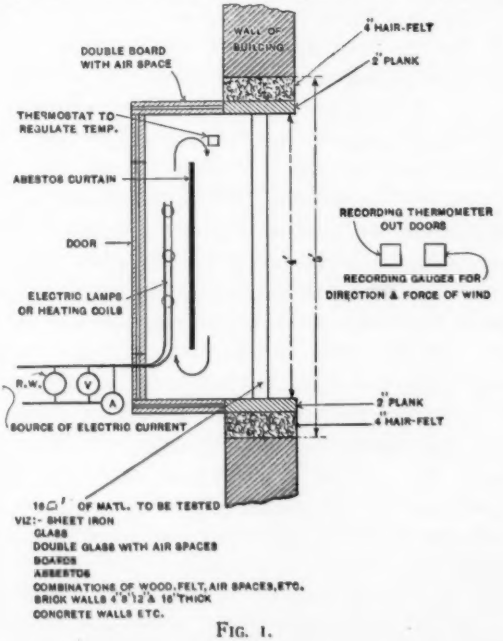


FIG. 1.

Here is the brick wall and here an opening in it 5 feet square. The opening is lined with a 2-inch plank with 4 inches of felt around it. The box extends into the room, where the temperature is 70 degrees, or any other temperature ranging from 50 to 80. We have in this space between the planks 16 square feet of substance to be tested—it may be a sheet of glass, or boards, or a 16-inch brick wall, plaster, or anything else that one wishes to test. Outside there is a recording thermometer, a recording anemometer, showing the force of the wind, and a recording weather vane showing the direction of the wind. The amount of heat transmitted through this 16 square feet of surface, if the temperature on the inside is kept constant, depends on three things—temperature out-of-doors, force of the wind, and the direction in which the wind strikes. Inside we have a closet protected by a non-conducting covering, so as to keep it at a uniform temperature, whatever may be the temperature of the room. Inside of the closet we put electric lamps or other electric heating device which will heat the air and keep it at one temperature. An asbestos curtain in front of the lamps prevents their radiating heat into the wall. A thermostat is used to regulate the current to these lamps, so the temperature in the closet is constantly kept at or about 70 degrees, and the actual temperature is registered by a recording thermometer. All the data are taken by recording instruments, so that the apparatus may be run for many hours without the attention of an observer, and from these data coefficients of transmission may be determined which should be more reliable than those of Peclet. The closet being thoroughly insulated on all sides except the 16 square feet of exposed wall, the heat transmitted through it is the same as that furnished by the electric current, and this is measured by a recording watt meter.

Mr. Cary: Professor Kent has suggested something very valuable and useful, but I would suggest the use of electric wires in the rear chamber instead of electric lamps. I know of experiments where they made some experiments with lamps and changed to wires and succeeded in getting better results. The exact number of B. T. U. delivered is obtained by watching the electric meter.

CLXXXVI.

RELATIVE CORROSION OF WROUGHT IRON AND SOFT STEEL PIPES.

BY T. N. THOMSON.

(Member of the Society.)

The physical properties of wrought-iron and steel pipes have been brought to my attention during the past few years, and I have spent considerable time trying to determine whether modern soft steel pipe is really superior or inferior to modern wrought-iron pipe for heating and plumbing purposes. The matter was originally brought to my attention by the pipe manufacturers, who stated that we are wrong in supposing that steel pipe is less durable than wrought-iron pipe. Indeed, they showed me the results of numerous tests which demonstrated that, as far as corrosion is concerned, the life of wrought iron and the life of soft steel are practically the same when the pipes are subject to the same conditions.

I did not doubt the records of these tests at all, but as they were principally laboratory tests I could not consider them as convincing as the condemnation of steel pipe by steam-fitters and contractors. Then we tried to investigate along practical lines. I had not gone far when we found that a peculiar condition of affairs exhibited itself as follows:

(1) A large proportion of the members of the heating trade denounced steel pipe, because, as they said, "It splits, breaks the teeth of the dies and rusts out too quick." Contractors who would acknowledge that they carried steel pipe in stock a few years ago could scarcely be found; they invariably all supposed they carried only wrought-iron pipe.

(2) Engineers and architects very freely specified that "wrought-iron pipe (not steel pipe) must be used, etc.," their impression being that the increased cost of wrought-iron pipe over steel pipe was more than compensated for in the greater period of usefulness of the wrought-iron pipe over the steel pipe.

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(3) Instructors in trade schools, professors in colleges, and even the writers of text-books were known to emphasize the supposed fact that steel pipe was not as durable as wrought-iron pipe, and that the latter should be used in preference to the former, particularly for underground work.

(4) On the other hand, statistics showed that the makers of steel pipe furnished about 80 per cent. of all the welded pipe then used in America. I also found that not only had the makers of steel pipe spent millions of dollars in the development of vast plants, but that they had also made a large number of experiments and tests to determine the relative durability of wrought-iron and steel pipes, and that their findings invariably were to the effect that the life of these two materials is about the same when they are subject to equal conditions.

(5) Wrought-iron pipe and steel pipe resemble each other so closely that many engineers, contractors, architects, and even steamfitters themselves, cannot distinguish a difference. I know this to be a fact, for I have tried a number of high-class representatives of these several vocations, and they almost all acknowledged that they could not determine the difference unless they were first to cut and thread the pipes; then those pipes which appear most difficult to thread they would christen steel pipes, while those which appear more easy to thread they would call wrought-iron pipes. But this process of determining a difference is not reliable, for it is a fact that a man working with sharp and properly designed dies can thread steel pipe almost as easily as he can thread wrought-iron pipe. This was demonstrated by a series of tests I made for the International Correspondence Schools in 1905, full records of which can be found in the 1905-1906 proceedings of this Society.

As by far the greater part of the every-day work of our students in heating and ventilation is principally the manipulation of welded pipes, we considered this subject of sufficient importance to investigate and try to find something absolutely definite regarding the relative corrosion of modern wrought iron and modern mild steel pipes when both are subject to the same actual working conditions as they occur in practice. With this end in view we commenced by quietly circularizing about 300 heating engineers and contractors, offering a book to each in exchange for a small piece of corroded pipe which had been in service only

a few years, we to pay express charges at our end. Each circular letter was accompanied by a sheet with printed questions relating to the history of the sample, and was provided with blank spaces for the answers.

My object in trying to obtain these samples and their histories was to find how many were wrought iron and how many were steel. I expected to find that at least 80 per cent. of the samples of corroded pipe sent to me would be steel, but they were not. Of the samples received only ten gave out within four years of service, six of these being steel and four being wrought iron. An examination of these samples showed that uniform corrosion took place in both the wrought-iron and the steel pipes. An excellent example of uniform corrosion of a $\frac{3}{8}$-inch black wrought-iron underground cold-water pipe came from Chicago. It had been in use three years; fully half of the metal was "eaten off" the outside, while the inside was but slightly corroded. There was no pitting present in this sample. Another good example of uniform corrosion was exhibited in a piece of $1\frac{1}{2}$-inch black wrought-iron exhaust pipe from power boilers in Tonawanda, N. Y. This had lain in damp soil and ashes four years before giving out. The thickness of this pipe varied from about one-half the original thickness to tissue paper thickness, but no pitting was present. The corrosion was chiefly external, and no doubt was due to the moisture and the ashes. But a better example of uniform corrosion was found in a piece of 2-inch steel pipe from Boston. This pipe was used as a wet return for a direct-radiation low pressure heating system, the pressure never exceeding 3 pounds. This pipe was put in February, 1904, and was removed March, 1905. The pipe was run on top of a cement floor over which was a plank floor on which coal was stored. Some of this coal worked down through the wood floor so that the pipe was partially buried in coal. After each heavy rain some surface water would leak through into the coal bin, so that it is probable the coal around the pipe was continually moist. The pipe was not covered with pipe covering. The corrosion was all external. The inner surface was not corroded in the least.

Three galvanized nipples were received from one party in Newark, N. J. They were reported to have been all taken from the same pipe line, which was used for hot-water circulation

between a tank and a heater for a house supply of hot water. Two of these nipples were wrought iron and one was steel. They were all pitted to about the same extent.

A study of the samples received from the trade would lead me to assume that (1) both wrought-iron and steel pipes which convey steam or hot water will corrode very rapidly when buried underground in wet or damp soil or ashes, the corrosion being principally external; (2) both wrought iron and steel pipes which convey hot water become rapidly corroded if the air and other gases naturally solvent in the water are not permitted to escape from the water previous to its passage through the pipes, as in feed-water heater connections and hot-water circulation pipes for plumbing purposes, this corrosion being principally internal if the pipes are not buried underground. (3) That the life of either wrought-iron or steel pipes subject to both of the aforesaid conditions will be much shorter than if the pipes are subject to only one of them, because the metal will thus become rapidly corroded at both the internal and external surfaces. (I received no samples which show this, neither have I made tests to prove it, but it seems rational to form this opinion at present.) (4) It is not a fact that the destruction of wrought-iron pipes is in the form of a uniform corrosion, while the destruction of steel pipes is in the form of pitting; they appear to be on an average nearly alike with the difference, if any, in favor of steel. Of course no definite conclusion can be drawn from the study of a number of pieces of corroded pipes received from different parts of the country further than the facts we can see in the samples themselves; for instance, the finest sample of uniform corrosion I received was mild steel. It came from Milwaukee, Wisconsin, is $\frac{3}{4}$-inch black steel pipe and is reported to have been used "for heating water in a range boiler for domestic purposes." It was in use two years. The corrosion is practically uniform without a sign of pitting. Part of the original thickness of the metal was corroded from the inside and about two-thirds from the outside. The pipe, which, no doubt, was originally standard weight, is now about $\frac{1}{16}$-inch thick at its thickest part and tapers down to tissue paper thickness in several places.

To secure a record of facts regarding the period of usefulness of steel pipe as compared with wrought-iron pipe it is necessary to test a large number of samples of both steel and iron pipes

subject to exactly the same conditions, and these conditions must be the same as the conditions of practice.

On March 7, 1906, I installed a number of pieces of wrought-iron and steel pipe for a corrosion test at the ceiling of the engine room in the Instruction Building of the International Correspondence Schools in Scranton, Pa., U. S. A., with the object of determining definitely whether steel pipe will last as long, or longer, than wrought-iron pipe, and by how much. The existing conditions were as follows:

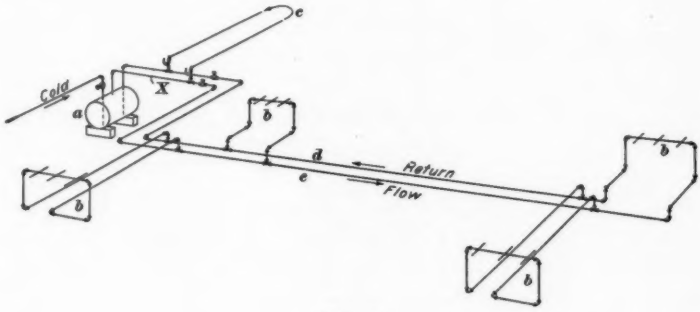

FIG. 1.

A 100-gallon galvanized iron boiler *a* in the engine room is set horizontally on two cast-iron cradles supported on brick piers. This boiler furnishes hot water to 24 combination cocks at four press-room sinks as at *b* and four slop sinks *c*. The water is heated by a 1-inch brass steam coil inside the boiler. The water comes from our city mains and has a working pressure varying from 85 pounds to 135 pounds per square inch by the gauge. This water comes from enormous reservoirs in the mountains about twelve miles away. An analysis of the city water made while the pipes were under test was as follows:

TABLE I.

CO_2 and Organic matter	29.33	parts	per	million.
Silica	4.00	"	"	"
Iron oxide	0.43	"	"	"
Alumina	0.37	"	"	"
Calcium carbonate	4.82	"	"	"
Magnesium	Trace	"	"	"
Sulphur trioxide	Trace	"	"	"
Sodium chloride	0.82	"	"	"

This may be classed as ordinary good water and should not affect iron or steel pipes in any extraordinary way.

The water on being heated in the boiler *a* circulates between the boiler and the sink cocks to insure hot water being drawn instantly when a cock is opened. The circulation is from the top of the boiler up through the flow pipe *d* and back through the return pipe *e* to become reheated in the boiler. These pipe lines are all composed of annealed brass pipe tinned both outside and inside and connected with heavy cast brass beaded fittings. A piece of 2-inch pipe 10 feet long was removed at *x* and replaced with ten short pieces of 2-inch iron pipe screwed together as shown in Fig. 2.

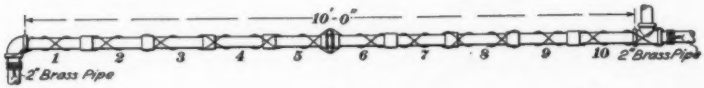

FIG. 2.

The temperature of the water as it flows through this pipe varies presumably from about 160 to 212 degrees, and the supply of hot water is maintained day and night all the year around.

Owing to the fact that these iron samples were connected to brass pipes, and also because a large number of presses and other printing and book-binding machinery driven by individual electric motors are used in this building, we wired and cross-wired the pipes with copper wire as shown, connecting the ends with perfect contacts to the brass pipes at *g* and *h*. This was done under advice from electrical experts to carry any stray current around the samples and thus avoid decomposition due to litic action. It was thought this precaution would insure a corrosion that would be due to nothing but the ordinary action of the hot water on each sample, and that no sample would be favored in any way. The samples were installed March 7, 1906; were removed March 14, 1907, and were in constant service during that time.

As soon as they were removed and separated, the ends were photographed (see Fig. 3) to show the rust formation and its thickness. The velocity of the water through the samples was always low; it never was high enough to wash out or dislodge the rust, which, therefore, formed a fairly uniform lining about $\frac{3}{8}$-inch thick in the black samples. The galvanized samples were

not affected this way; they corroded only in spots which presumably were imperfections in the galvanizing.

Before installing the samples we weighed each one separately without the couplings, so that after the rust was all washed out and the samples weighed again the difference in weight indicated the total weight of metal lost by corrosion. Here we found that in the plain pipes 9 $\frac{13}{32}$ lbs. of wrought iron lost 20$\frac{3}{4}$ ozs., while

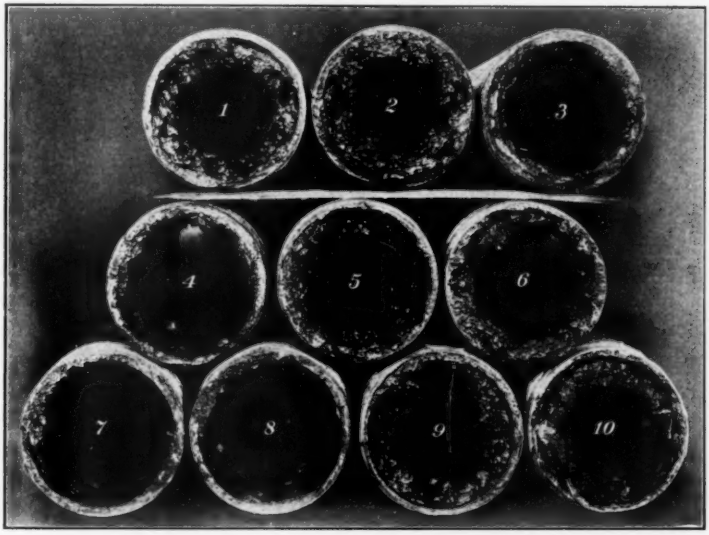

FIG. 3.

9 $\frac{14}{32}$ lbs. of steel lost 24$\frac{7}{8}$ ozs. (The galvanized samples are not included here because the zinc coating affects their durability.)

This is where we are tempted to stop short and conclude that as the steel pipe in this test has lost more metal than the wrought-iron pipe it follows that the wrought-iron pipe is the more durable. But such a conclusion would be misleading and absurd in the extreme, because the life of a pipe depends not upon the amount of the corrosion but upon the deepest pitting. A certain pipe may lose only 1 per cent. of its weight by corrosion when it begins to leak from some pittings, while another pipe may have lost 50 per cent. of its weight by corrosion and still be perfectly tight and serviceable. Therefore, it appears evident that in order to determine the relative life of the samples it is

necessary to measure the depth of the pittings and base conclusions on these measurements.

With this end in view, we sawed open each sample lengthwise; then an expert in micrometer measurements, a tool maker accustomed to very fine work, was detailed to measure the depth of the five deepest pittings in each half, making 100 micrometer measurements. It really was only necessary to measure the deepest pitting in each piece, but to locate it by the eye was impossible. By selecting the five which appeared to be the deepest, however, we felt sure that we measured the deepest pitting in each piece.

The accompanying Table I. is a record of the results of this test.

The thickness of the metal under each pitting was first measured by "Starrett" transfer calipers having sharp points; then a very delicate small inside caliper was used to just touch the points of the transfer caliper, and the distance between the points of the inside caliper was measured with a 1-inch micrometer. Each pitting was measured in the same way and by the same person. The measurements recorded here are believed to be correct to within $\frac{1}{1000}$ of an inch.

Figs. 4, 5, 6, 7 and 8 are from photos of the samples after they were cut in halves. A close examination will show quite a difference between the corrosion of the steel and the iron.

Summary.

Assuming that corrosion had been continued at the rate which existed during the period of the test, then the different samples would have become corroded through at the end of the number of days given in the accompanying Table II.:

TABLE II.

DURABILITY OF THE SAMPLES.

Plain Pipe.			Galvanized Pipe.		
No. 10.	Steel pipe	850.4 days.	No. 8.	Steel pipe	1162.9 days.
No. 5.	Wrought-iron pipe	780.5 "	No. 3.	Wrought-iron pipe	1162.9 "
No. 6.	Steel pipe	780.5 "	No. 7.	Wrought-iron pipe	770.0 "
No. 2.	Steel pipe	759.7 "	No. 4.	Steel pipe	619.3 "
No. 9.	Wrought-iron pipe	759.7 "			
No. 1.	Wrought-iron pipe	686.5 "			

TABLE I.

	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6		No. 7		No. 8		No. 9		No. 10	
KIND OF PIPE	Blk.W. Iron		Blk. Steel		Galv.W. Iron		Galv. Steel		Blk. W. Iron		Blk. Steel		Galv.W. Iron		Galv. Steel		Blk.W. Iron		Blk. Steel	
Weight without coupling when put in.	$3\frac{13}{64}$ lb		$3\frac{3}{32}$ lb		$3\frac{15}{32}$ lb		$2\frac{25}{32}$ lb		$3\frac{3}{32}$ lb		$3\frac{5}{32}$ lb		$3\frac{10}{32}$ lb		$3\frac{18}{32}$ lb		$3\frac{7}{64}$ lb		$3\frac{3}{32}$ lb	
Weight without coupling when removed and rust washed out.	$2\frac{26}{32}$ lb		$2\frac{20\frac{1}{2}}{32}$ lb		$3\frac{13}{32}$ lb		$2\frac{23}{32}$ lb		$2\frac{20\frac{1}{2}}{32}$ lb		$2\frac{19}{32}$ lb		$3\frac{6}{32}$ lb		$3\frac{15\frac{1}{2}}{32}$ lb		$2\frac{21\frac{1}{2}}{32}$ lb		$2\frac{18}{32}$ lb	
Lose in weight by corrosion	$6\frac{1}{4}$ oz.		$7\frac{3}{8}$ oz.		1 oz.		1 oz.		$7\frac{3}{8}$ oz.		9 oz.		2 oz.		$1\frac{1}{4}$ oz.		$7\frac{1}{8}$ oz.		$8\frac{1}{2}$ oz.	
Per cent. loss.....	12.2%		14.9%		1.8%		2.2%		14.9%		17.8%		3.8%		2.2%		14.3%		17.2%	
	1	1 *X*	2	2 *X*	3	3 *X*	4	4 *X*	5	5 *X*	6	6 *X*	7	7 *X*	8	8 *X*	9	9 *X*	10	10 *X*
Depth of five deepest pits in each half of each sample in inches.	.078	.060	.056	.061	.048	.030	.055	.092	.073	.057	.053	.065	.048	.050	.049	.041	.045	.062	.051	.056
	.078	.083	.045	.069	.043	.042	.044	.082	.072	.045	.046	.073	.059	.027	.031	.040	.044	.066	.037	.052
	.072	.074	.068	.071	.038	.049	.045	.068	.062	.062	.063	.053	.055	.060	.042	.025	.057	.075	.043	.066
	.080	.076	.069	.063	.029	.023	.038	.070	.073	.058	.033	.053	.070	.074	.026	.048	.069	.054	.041	.067
	.072	.059	.069	.075	.029	.016	.058	.050	.050	.056	.042	.065	.049	.068	.041	.046	.042	.050	.062	.045
	1	1 *X*	2	2 *X*	3	3 *X*	4	4 *X*	5	5 *X*	6	6 *X*	7	7 *X*	8	8 *X*	9	9 *X*	10	10 *X*
Thickness of metal under pits in inches.	.076	.094	.098	.093	.106	.124	.099	.062	.081	.097	.101	.089	.106	.104	.105	.113	.109	.092	.103	.098
	.076	.071	.109	.085	.111	.112	.110	.072	.082	.109	.108	.081	.095	.127	.123	.114	.110	.088	.117	.102
	.082	.080	.086	.083	.116	.105	.109	.086	.092	.092	.091	.101	.099	.094	.112	.129	.097	.079	.111	.088
	.074	.078	.085	.091	.125	.131	.116	.084	.081	.096	.121	.101	.084	.080	.128	.106	.085	.100	.113	.087
	.082	.095	.085	.079	.125	.138	.096	.104	.104	.098	.112	.089	.105	.086	.113	.108	.112	.104	.092	.109

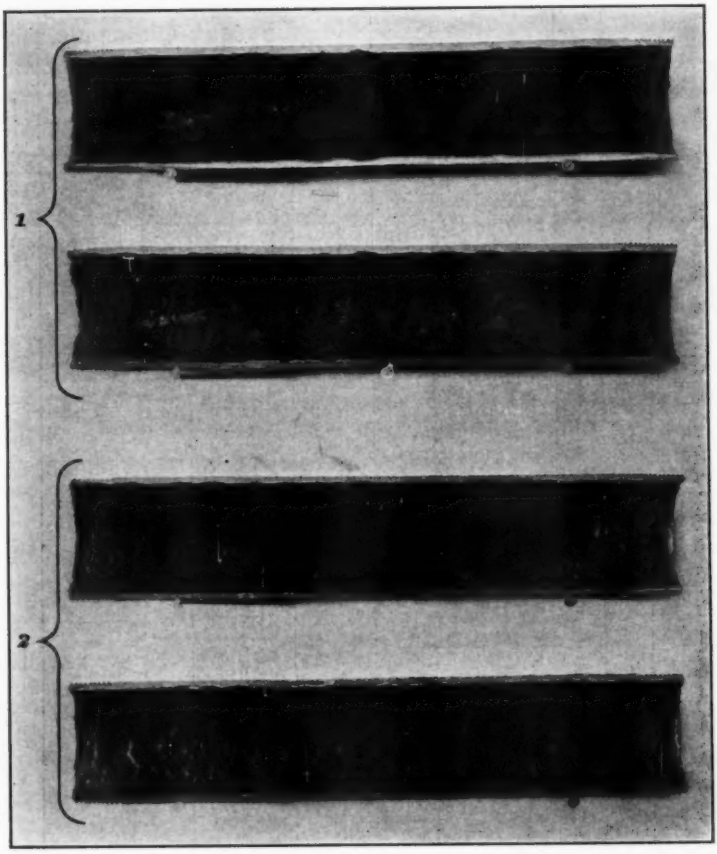

FIG. 4.

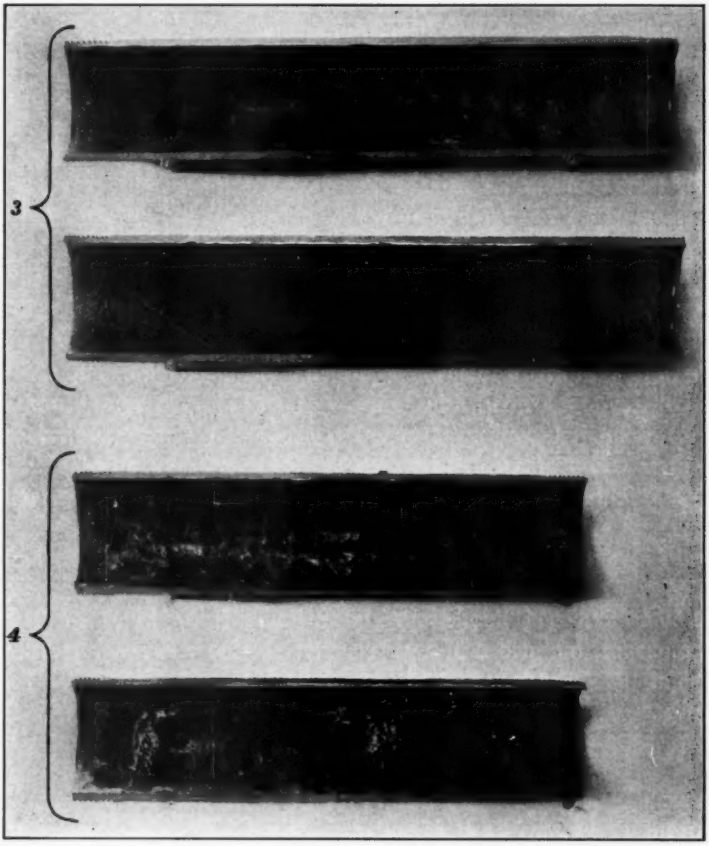

FIG. 5.

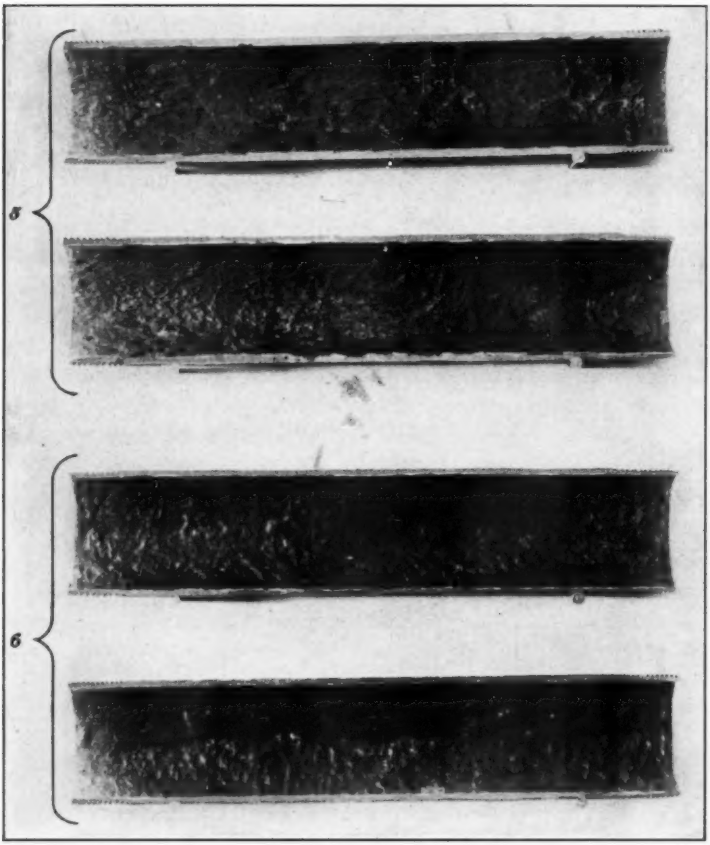

FIG. 6.

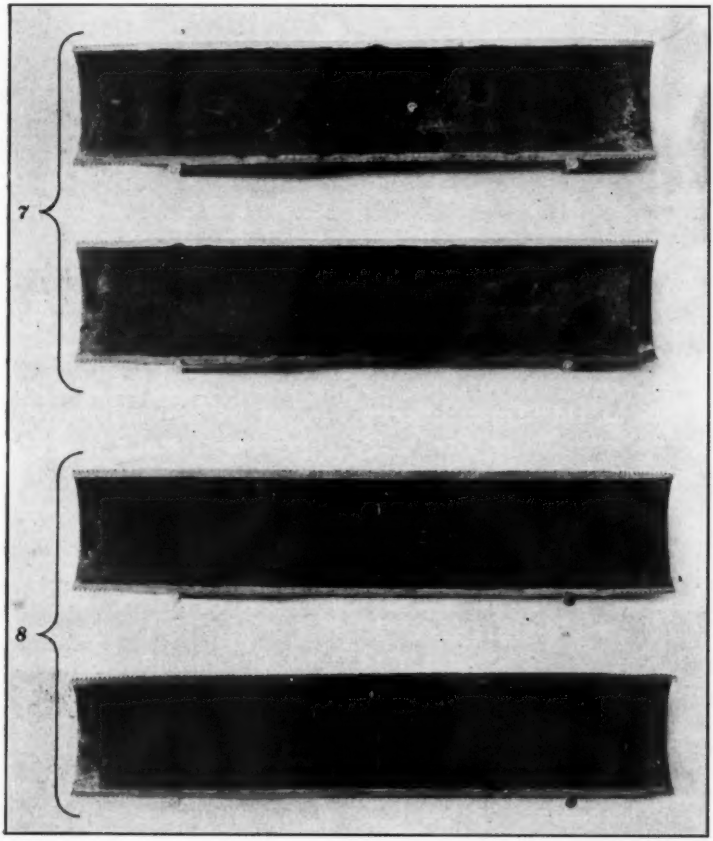

FIG. 7.

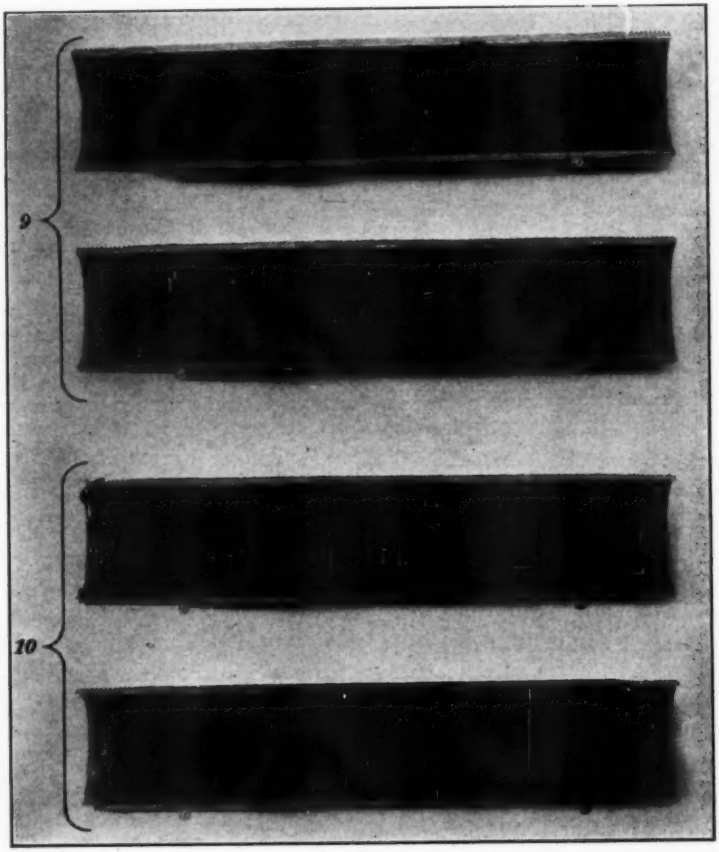

FIG. 8.

The average life of the plain steel pipe samples is 796.9 days, while the average life of the wrought-iron samples is 742.2 days, making a difference of 54.7 days in favor of steel. Therefore, a rational deduction to draw from the preceding facts is that plain steel pipe is more durable than plain wrought-iron pipe when used to convey hot water and subject only to internal corrosion.

I know that the above summary is not in perfect harmony with the opinions of many engineers and contractors, but I can only record the facts as they are found. I have brought the samples here for inspection and checking if you so desire. If any errors can be discovered either in the method of making the test, obtaining the data, or in the deduction, I will be pleased to know them.

DISCUSSION.

Mr. Cary: This is a very interesting paper and it adds information upon a subject about which too little exists. The Scranton experiments merely give us the results obtained from one condition, or set of conditions, which cannot exist elsewhere. It is very essential in making a study of this kind to understand the different methods by which waste occurs in the pipes. Pitting is caused by a different set of conditions from general corrosion. If the water contains considerable air in solution, as the air leaves the water it leaves it much higher in oxygen than it is in the atmosphere, and it is much more active in its action on wrought iron and steel than atmospheric oxygen. The bubbles of air appear on the surface at some central point, and after the action is once started at one of these points, other bubbles centre at the same point and rapid corrosion results.

In a series of articles written by me in the *Engineering Magazine* of March, 1907, I considered the different kinds of corrosion. General corrosion, corrosion which occurs over a large area of pipe and covers it very uniformly, may generally be traced to the presence of an acid, either organic or inorganic. Where pitting occurs it is almost invariably due to the presence of air in the water.

In the analysis given in Table I, we have the solid contents of the water carefully analyzed, but there seems to have been no attempt made to determine the quantity of dissolved air in this

water. It is not safe to take the solid matter which will be precipitated in the water as an index of its pitting quality. In Switzerland there are large lakes supplied almost entirely by melting snow, and it can be evaporated to dryness with a small trace of organic matter. In Glasgow the water is extremely pure. In the waters of the Irish lakes and most of the Scottish lakes there is a very large solution of air, and in the boilers in these localities very active pitting occurs, and they even have to mix a solution of quick-lime in the water to protect the boilers and tubes from this active pitting action.

In a certain feed-water heater, in South Brooklyn, a tremendous pitting action had taken place, and it was found almost entirely due to stray electric currents, short-circuited currents, and the tubes were badly corroded.

It is of interest to note the relative durability of samples produced: plain iron, galvanized pipe, and steel pipe. Where there is zinc on these pipes, if any electrolytic action occurs the zinc is more apt to disappear, and the action will be at the expense of the zinc rather than at the expense of the iron, and as long as the zinc is near where this action is taking place, the iron will be more or less protected.

CLXXXVII.

TOPICAL DISCUSSIONS.

TOPIC NO. 1.

"The Additional Amount of Radiation Seeming Advantageous for Warming Rooms Exposed to the Strongest Wind Effects."

DISCUSSION.

H. W. Whitten: I have had occasion during the last year to make investigations as to window leakage. Many of them were crude, but, taken as a whole, there were some satisfactory results. In order, however, to carry the thing further, we erected an apparatus consisting of a fan attached to a sheet iron cone which was flanged to a window frame so there was no leakage. This window frame contained an ordinary window, 2 feet by 4 feet. This window was then subjected to pressures from the fan, varying from nothing up to about 2.3 inches. Various sashes were tested, one with 1/32 inch clearance all round; the next one with 1/16 inch clearance, such as an ordinary window 2 feet by 4 feet. This one was protected with a good type of metal weather strip, the object being to find out how much leakage we got with the varying conditions. A cone was attached to the frame on the opposite side from the fan and the leakage was measured by an anemometer.

The results were rather astonishing to myself and to the others who participated in the experiments. To boil the thing down, it was shown that about 30 B. T. U. for every square foot of glass surface was the leakage in the ordinary window of that type with 1/32 inch clearance; and that was increased to about double for the 1/16 inch clearance. As the higher pressures were reached, the leakage did not increase in proportion to the pressure, the assumption being that the pressure of the wind on the sash set it closer against the stops and prevented proportionate increase.

The figures at the 1/10 inch pressure give, per lineal foot,

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either on the side or across the window, with the 1/32 inch clearance, 105.6 cubic feet per foot of joint per hour. For 1/16 inch clearance, 184.9 cubic feet one foot of sash in one hour. With the metal weather strip, 12 cubic feet. We all agreed that 1/10 inch pressure equalled a wind velocity of about 15 miles per hour; 5/10 inch equalled about 34 miles per hour, and gave 279 cubic feet per foot of lineal joint in the 1/32 inch of opening; 1/16 inch, 402 cubic feet per foot of lineal joint; with the metal stop 45.6 cubic feet. Going on up to 1 inch, which is practically 48 miles per hour, 434 cubic feet with the 1/32 inch clearance and 591.6 cubic feet with the 1/16 inch clearance, and 69 cubic feet in the metal stop window.

Very many tests were made at each one of these pressures and an average struck, but the variation was very little. The highest pressure, 2.3 inches, of which I have no practical record here, was obtained by discharging air into a cone, tightly enclosed, and there would be, of course, no lateral motion of air. The lower pressures were obtained by opening a slide in this cone, allowing a lateral motion of the air, which was quite large.

What led me to look into this matter more than any other one thing was the fact that some years ago, in Baltimore, a building was erected, containing about 15,000 square feet of radiation, windows of ordinary double hung sliding type. After a metal strip was applied to these, the interior temperature was raised 10 degrees. About 25 per cent. of the radiation was removed from the building and the average interior temperature reduced thereby to a normal condition.

The point I wish to make is that engineers should have some uniform method of treating the openings about windows, insisting that they be properly treated and not put themselves at the mercy, so to speak, of the contractor, who puts in a variable something which only partly excludes the air and does not give protection against unfavorable conditions.

Mr. Franklin: I was interested in testing the heating and ventilating apparatus in a certain school building, to find that in some cases 50 per cent. to 60 per cent. more air passed out through the vent ducts than came in through the warm air inlets. I called the attention of the Chairman of the Building Committee to this large amount of air leakage around the windows, and received the reply, that until the heating of the build-

ing was criticised he didn't see that I had any reason to find any fault. In this building the school children were obliged to move away from their seats near the windows. When there was a high wind and a very fine snow, so much snow came in around the windows that it had to be swept up, practically shovelled out of the school room. So this is a condition we are up against at times, and if we could obtain relief from this condition of affairs it would be a good thing.

Mr. Whitten: In several cases, since I took this matter up, heating plants have been designed on the basis of the large elimination of radiation on account of reduced window leakage. In most cases the reduction in the cost of the heating plant has been sufficient to pay for the application of the device to the windows.

Mr. Chew: There is evidently a very interesting question involved here. The engineer told a few of us this building was heated by the downward system—the air comes in around the ceiling and the foul air goes out of the doors, so that it is not necessary to open the windows to ventilate. From what I have heard about leakage I should think it would not be necessary to open the windows. On the other hand, with the wind blowing thirty or forty miles against these windows, isn't it enough to interfere with the flow of air coming in through the registers? Certainly there is more pressure in a fifty-mile wind than the fan creates. Most of the engineers are occupied in heating residences, and even with a direct system there is some ventilation with the cracks around the windows, and better if any indirect system is used. The advice of others is to close all these cracks up and use double sashes, etc. So there is more than one question involved. There is a class of residences with transoms over the doors and casement windows. I do not know whether you gentlemen have ever seen an air-tight house.

Was the system Mr. Franklin referred to the double system, one fan bringing the air in and another fan taking it out, or one fan pulling the air out and getting ventilation the best way they could?

Mr. Franklin: There was a fan system, but the trouble was it was a very faulty case of window construction. It did not prevail except under high wind pressures. With the high wind pressures we were taking out an enormous amount of air, very much in excess of the amount of air we were putting in.

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TRANSACTIONS

OF THE

SEMI-ANNUAL MEETING

Niagara Falls, N. Y., July 24, 25, 1908.

CLXXXVIII.

PROCEEDINGS OF THE SEMI-ANNUAL MEETING.

Niagara Falls, N. Y., July 24, 25, 1908.

PROCEEDINGS.

First Day—Morning Session.

(Friday, July 24, 1908.)

The meeting was called to order by President James Mackay, at 10.40 A.M.

President Mackay: First is the roll call of members.

Secretary Mackay: Before calling the roll I will announce the names of those who have been elected members of the Society since the last meeting.

James B. Badger	Member.
Oliver L. Badger	"
Joseph H. Burton	"
John T. Bradley	"
Philip M. Beecher	"
William D. Clark	"
Byron T. Gifford	"
Robt. L. Gifford	"
Wm. Grier	"
William H. Johnson	"
Theo. Karr, Jr.	"
Dwight D. Kimball	"
Francis W. McGuire	"
Harry M. Nacey	"
George J. Phillips	"
Frank N. Speller	"
D. Stephen Tallman	"

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Raymond M. Stackhouse.....Associate.
Herbert W. Whitten..... "
Charles W. Miller.....Junior.
Harry W. Terry..... "

The Secretary then called the roll and reported a quorum present.

President Mackay: The next number on the programme I see is the President's address.

PRESIDENT'S ADDRESS.

It gives me great pleasure to open this, the Twelfth Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers. This is our fourteenth year, and, as you all know, our history has been a record of constant progress. Since that summer meeting held in this same city five years ago, our growth has been rapid—from one hundred and nineteen members, in fact, until we now number three hundred and thirty-two members all told. These figures represent gratifying quantity, but we are proud to say a like quality.

All our bills are paid, and we have a balance in the hands of the Treasurer of two thousand dollars.

Now, while even in our elation over our Society's advancement, we might not be willing to answer in the affirmative to the old taunt: " No doubt but ye are the people and wisdom shall die with you." Still our modesty does permit us to feel, yes, to know, that no matter what question of importance in our profession may come up, we can always select some from our membership who are such authorities or have had such experience that they are exactly " the people " to throw light upon the subject. Thus, our meetings are always instructive and interesting. The latter summer assemblies have been particularly so, and this session bids fair to register no retrogression.

I find in looking through our invaluable records that the making of an address by the President at the summer meeting is a " custom more honored in the breach than the observance," and so in accordance with such an excellent precedent, I shall take up no more of the valuable time of this all too short convention except to add that it is the custom of the American So-

ciety of Heating and Ventilating Engineers to accord the privilege of the floor to visitors.

We hope to have a free and open discussion of papers and subjects, and we want every one to feel free to talk and bring out every point. We hope the proceedings will be beneficial. There are many questions brought up since the programme was issued that are of vital interest.

I will ask the Secretary to read a communication.

(Secretary Mackay here read a communication from Clayton W. Old, of New York City, relative to the enforcement of the laws for better ventilation.)

Secretary Mackay moved that action be deferred until the afternoon session. Agreed to.

President Mackay: Next is reports of committees.

Secretary Mackay: The committees were notified of their appointments. While no official report is requested from them at this meeting any suggestions they may want to make will be received.

President Mackay: As I understand these committees, their reports should be first submitted to the Committee on Standards. We have been having a great many reports from time to time from committees that have not been so submitted. Should not all these reports go to the Committee on Standards? Should not there be some action in connection with the committees' reports, and in that way go to the Committee on Standards?

Some discussion followed in regard to the work of committees.

DISCUSSION CONCERNING REPORTS OF COMMITTEES (ABSTRACT).

Mr. Chew: When a report is prepared by a committee and presented to the Society there is a strong probability of a discussion of the findings of the committee, and then if the report, with the discussion, is referred to the Committee on Standards, the final report made to the Society is likely to be a better report than it would be otherwise. I think that if you compel committees to report to the Committee on Standards you will frustrate the very design of the appointment of the committees. The committees can report to the Society and their reports be discussed and referred with the discussion to the Committee on Standards for revision, with the result that the final report will be fully in

keeping with the technical standard which the Society hopes to maintain. That is my idea upon the subject.

President Mackay: My idea is that every committee should report to the Society, and then the result of their labors be turned over to the Committee on Standards, which should put it in shape for adoption or for the Proceedings.

Mr. J. D. Hoffman: I would like to have information as to where the dividing line is between the Committee on Tests and the Committee on Standards.

Secretary Mackay: When the Society was organized there were certain objects in view. One of them, No. 2, was for the "improvement in the mechanical construction of the various apparatus used for heating and ventilating." That was thought to come under the question of tests. No. 4, "To establish a clearly-defined minimum standard of heating and ventilating for all classes of buildings." It was thought that while any committee might inquire into or attempt to establish a standard in any one line, while they might dig a little bit further on that particular line than the Committee on Standards, yet it should go for revision before the Committee on Standards who could submit it as a standard for the Society.

The Committee on Compulsory Legislation has been looked upon as a good committee, and has accomplished considerable. We have a law in New York, and also in Pennsylvania and New Jersey.

Mr. J. D. Hoffman: I want to offer to the Society the availability or usefulness of the Committee on Tests. I think all the members should send in to us any information they have which in their own opinion would not make a paper of sufficient size to present to the Society—anything that can be compiled. We offer our services. I am sure that is what we are for. I sent a letter out to the membership last year, a circular letter, and I believe I heard from one. I want to suggest to you that our report will depend largely upon how much information we can gather from the individual members.

Mr. Chew: There is in the Society a lot of information on which both the Committee on Tests and the Committee on Standards can work. I believe the time is not far distant when it will be necessary for both the Committees on Standards and Tests to go over the proceedings of the Society, and reports of

various committees, to classify the information they contain. At one of the annual meetings Mr. Barron suggested that a committee be appointed to do this valuable work.

President Mackay: The next item on the programme is a paper on "Reasons why the Science of Heating and Ventilating Should be Observed," by J. D. Hoffman.

Mr. Hoffman read the paper, and it was discussed by Messrs. Chew, G. D. Hoffman, Gordon and Oldacre.

Mr. R. S. Thompson's paper on "A Hot-air Furnace in a House without a Cellar" was then read by Mr. Chew, and discussed by Messrs. Jones and Chew.

Topic No. 1, "Rules in Furnace Heating," was discussed by Messrs. Chew, Miller, Jones, C. B. Thompson, Oldacre and J. D. Hoffman.

Topic No. 2, "The Effect of Increased Pressure in Hot-water Heating Systems," and Topic No. 3, "The Comparative Value of Forced and Gravity Circulation in Residence Hot-water Heating Systems," were discussed by Messrs. Donnelly, J. D. Hoffman, Chew and Secretary Mackay.

On motion the meeting adjourned until the afternoon.

First Day—Afternoon Session.

(Friday, July 24, 1908.)

The meeting was called to order at 2.50 P.M. by President Mackay.

Secretary Mackay: Mr. Bennett, of the Bureau of Publicity of the City of Niagara Falls, desires to make some remarks.

Mr. Bennett spoke briefly, describing the entertainment that had been provided by the Bureau for the visiting members.

Mr. Hale then presented the report of the Illinois Chapter.

A paper on "Simplifying the Installation and Operation of School Heating and Ventilating Apparatus," by S. R. Lewis, was read by Mr. Capron, and was discussed by Messrs. Weinshank, Hale, Dugger, Johnson, Kauffman, Donnelly, Chew, Secretary Mackay and J. D. Hoffman.

Topic No. 4, "Air Washers and their Effect," was then discussed by Mr. Kauffman, and Topic No. 5, "The Effect of Air

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Leakage Around Windows on Heating Apparatus," by Messrs. Whitten and C. B. Thompson.

On motion the session adjourned.

Second Day—Morning Session.

(Saturday, July 25, 1908.)

The meeting was called to order by President Mackay at 10.10 A.M.

President Mackay: We have a letter from one of our members which relates to charges for engineering work and to the right of ownership of the engineer to plans and specifications which he prepares for use by an architect. The Secretary read the letter.

Secretary Mackay: On page 47 of the charter it says: "To establish a uniform scale of prices for all professional services." So that is one of the subjects that is well within our province to discuss. I replied to this letter that my personal opinion was when I prepared specifications for an architect, he paying me, they were his property, but when the owner employed me, and I worked in conjunction with the architect, the plans and specifications were mine, and that I would get the views of other members.

President Mackay: It seems there is a little difference of opinion as to what would be the proper mode of procedure. It would be well for us to express a preference for one method or the other. The reply of the Secretary should be very satisfactory.

Mr. J. D. Hoffman: If nothing is said before the architect employs the engineer, I believe the architect should own the tracings.

President Mackay: I do not know there is anything for us to do in the matter, except to answer Mr. Ingalls, but it would be well if some established practice were arrived at.

Mr. J. D. Hoffman: If nothing is said about ownership when the architect employs the engineer, it seems reasonable that the architect should own the tracings, as the Secretary has inferred. Such tracings may be held by the engineer in deposit, with free access to them by the architect. It would be well, however, in every case to have a definite understanding before starting the work.

Mr. Berry: It seems to me it would be the proper thing, if the

Society has not already done so, to establish a basis for arriving at a charge for engineering services, whether a percentage similar to the architect's charge, or a price per day.

Work which is done directly for the architects upon new buildings generally will carry a percentage charge, but old work, which is already in operation and about which expert advice as to conditions existing and remedies for evils found should have at least minimum charges established by this Society. It has often been the case that the charge was made according to what the traffic would bear.

Secretary Mackay: In the early days of the Society we had a Committee on Relationship Between the Engineer and the Architect and in conjunction with the committee appointed the American Institute of Architects worked on that line, and in the architects' scale of charges to-day they have a clause that " where it becomes necessary to employ a heating and ventilating engineer, mechanical engineer, or electrical engineer or other engineer, to assist the architect in his labors, they are to be paid by the owner of the building in addition to the architect's fee."

Something has been said about flues. It depends on how the contract is taken. If a man agrees to heat a building to a certain temperature, it is supposed or assumed he specified that the owner was to supply a flue of sufficient area and draft. I have known of cases where the heating contractor after taking the contract, found he had no draft, and told the owner the flue was not of sufficient capacity. The heating contractor had to build a larger flue.

Mr. J. A. Donnelly: I think it is well established that an architect's plans made for one building may not be used for another building. The architect has to be paid over again. I don't see why the architect who employs a heating and ventilating engineer and engages him to make plans for heating and ventilating should be allowed to retain those plans and use them for a second building without paying the heating engineer. It is a well-established rule that he gets paid. It is established that the design is the property of the architect and must be returned. Another building cannot be put up from the same plans without compensating the architect again. If that is true, the heating engineer should be entitled to be paid for a second building the same as the architect.

President Mackay: That would be true if ethics were rigidly adhered to. The architect would not use the engineer's plans a second time.

Mr. Berry: In the case I spoke about the matter of flue was not specifically mentioned. They had some sort of verbal understanding that the chimney was there and good, or something of that sort. But my understanding of the matter is, that the uniform practice or plan of the Furnace Manufacturers' Association —several I have in mind, one in Canada, one in New York, one in Pennsylvania—provides that the owner shall supply the flue, and that if it is not good he shall promptly provide suitable draft. It is my understanding that the custom of the trade, unless specifically stated to the contrary, is for the owner to provide the chimney. If that is not the general understanding, I think it would be a very desirable thing the Society should be on record as to the general custom.

President Mackay: That would depend on the contract, which should include a clause "the owner is to furnish a chimney of good and sufficient draft." If that clause is omitted and the contractor guarantees to heat the building if it develops that the chimney is not sufficient, it looks to me as though he were responsible.

Mr. J. J. Blackmore: The designs are the property of the engineer. The engineer furnishes the plans, and, therefore, he has ownership right in the plans. The architect also has some rights the engineer cannot overlook.

Secretary Mackay: I think it is largely a matter of agreement between the engineer and the architect. Any plans the architect owns bear the stamp, "Property of So-and-So, architect," and are to be returned to him on completion of the building, and not to be used for other purposes unless by agreement.

Mr. Chew: Some years ago there was this discussion, and, I think, if you will read the report you will find an agreement in the Proceedings some years back, and you will find the question is pretty well answered.

President Mackay: Is that discussion or paper recognized as the custom? Did it establish anything, or is it the custom, Mr. Chew?

Mr. Chew: I think there is an agreement between the Amer-

ican Institute of Architects and this Society along certain lines. Just what they are I cannot state. A topic don't carry with it the obligation of the Society to discuss it, but if the letter is answered I think it should convey the information from the paper read on the relation of the architect and engineer, giving the year.

Secretary Mackay: Endorsement shall not be given to any individual or firm or for any scientific mechanical or engineering production.

President Mackay: This discussion is on establishing a uniform scale of prices for engineering work. Unless some of our members have some more remarks to make on the subject, we will leave it in the hands of the Secretary to treat as has been suggested.

Topic No. 6, "The Proportion of Radiator Surface and Method of Ventilating Rooms for Drying Macaroni," was discussed by Messrs. Hale, Weinshank, Kauffman, Donnelly and Chew.

President Mackay: We will take up the letter from Mr. Clayton W. Old relative to the enforcement of the laws for better ventilation. The Secretary can read the letter.

Secretary Mackay read the letter.

President Mackay: You have heard the letter. It is a subject we are all interested in, and it would be rather an embarrassing matter if such a law on the statute books should be rendered null. If there is anything we can do, I think we should do it.

Mr. Weinshank: It has been said the West is copying from the East. I want to turn the table around and say that the East ought to copy from the West. About ten years ago Miss Jane Addams, of Chicago, went before the Legislature of Illinois and obtained the passage of a bill to the effect that every factory should provide proper ventilation, that every emery wheel should be provided with a proper hood. Inside of a year every factory in Chicago was equipped with proper hoods, proper fans, etc., and I will say that to-day the factories in Illinois are in better condition in that respect than those in any other State in the Union. There is a fine for non-compliance with the law, and also a reward is offered to anyone who will prosecute and convict the owner of a factory building which is not equipped ac-

cording to law. It seems to me it is the duty of this Society not only to go on record in favor of these laws, but to aid the factory inspectors in enforcing them and in prosecuting offenders.

Mr. Chew: The law is on the statute books. The trouble is there is the money back of the organized league to have the law repealed or amended so as to nullify its effect.

Secretary Mackay: On this point Mr. Weinshank brings up the State government of New York undertakes prosecution as soon as they find any violations of the law, and it is covered by heavy fine.

President Mackay: This subject is one in which we are deeply interested. We already have a Committee on Compulsory Legislation, and it can be increased. Something should be done. What is your pleasure?

Mr. J. A. Donnelly: I think this communication should be sent to the Committee on Compulsory Legislation to properly dispose of it, and I make that as a motion.

Mr. Chew: I suggest to the Committee on Legislation that three members from New York take the work in hand. I suggest three men be recommended from the standing Committee on Compulsory Legislation.

President Mackay: Most of the members on the committee are Western members.

Secretary Mackay: It seems to me that we, as a society, in session assembled, should strongly endorse this law as it appears on the statute books, and commend Mr. Walling, the factory inspector, for his enforcement of it, and we should then turn over the matter to our Committee on Compulsory Legislation for such further action, as would assist in maintaining the law on the books and the enforcement of it.

The motion was duly seconded and carried.

Mr. Davis: My motion is that this Society heartily endorse the action of Mr. Walling and approve of his enforcement of the law now on the statute books.

President Mackay: You have heard the motion. Are there any remarks? None.

The motion having been duly seconded, was agreed to.

Mr. Theodore Weinshank read a paper on "Air Cooling." It was discussed by Messrs. Whitten, Donnelly and Macon.

Mr. Capron: Professor Kent, of the Committee on Standards, sent in a letter stating he is unable to attend the meeting on account of sickness, but would like to get an expression from members regarding our work if they have anything in mind, any suggestions.

Mr. Hale: At one of the meetings of the Illinois Chapter the writer brought up the question of the possibility of establishing a standard for outside temperatures, that is, the standard that specifications should call for in certain localities. Quite often contractors will figure on a plant and will put in their specifications "to heat the building to a certain temperature at zero." Another man figures on the same job, and he specifies he will do it at 10 degrees below. The result is, it is difficult for the architect to determine which is the better proposition.

The question has come up as to whether it would not be wise for the Committee on Standards to make inquiry as to the temperatures generally figured in different localities of the country, and have it arranged so that if certain members of this Society or certain contractors are figuring on a plant in the South, in New Orleans, or in Texas, they will have the same outside temperature others are figuring on, instead of one man figuring at zero and another man at 20 degrees above and another at 10 degrees above. The same would apply to St. Paul and that district, where one man would figure 15 below outside temperature, and another would figure 40 below.

A communication was sent to the Secretary of the Society from the Chapter, covering this point, and, as it has not been mentioned here, I suggest it be considered now and put up to that Committee on Standards.

Secretary Mackay: It seems to me the Committee on Standards could get valuable data from the Weather Bureau as to average temperatures and extremes, which would be more authentic than you could get in any locality.

Mr. Hale: It is true you can get from the Weather Bureau a statement of extreme temperatures. In Chicago we have had it 20 to 25 below zero, but that does not mean we figure our radiation on that basis. However, I do know there are contractors and engineers, some of whom would figure zero, 10 below, 15 below, and, if contractors are figuring on the same job, and each

one figures on different outside temperatures, the amounts of radiation are not going to be correct. The question is what standard should be used for different localities?

Mr. Donnelly: Two below is the coldest we get in New York, and we usually write specifications guaranteeing to heat the building 70 degrees in the coldest weather, which would apply everywhere.

Mr. Hale: Who decides what is the coldest weather?

Mr. Donnelly: The thermometer.

Mr. Hale: If you figure on a job you must have some basis to figure on.

Mr. Donnelly: Consult the heating and ventilating magazines. They have all the facts.

Mr. Whitten: The records referred to *The Heating and Ventilating Magazine* also contain the wind velocities. There seems to be a wide divergence in this respect among the heating engineers. One will figure on 10 degrees above zero with a forty mile wind, and another on 15 degrees above zero with a fifteen mile wind. It seems to me the conditions in each locality should be taken into consideration.

Prof. J. R. Allen's paper on "Coefficients of Transmission in Cast-iron Radiators," which was presented in manuscript at the January meeting, was taken up for discussion. A large part of the paper was devoted to the subject of the room temperatures that should be obtained in testing direct radiation systems when the outside temperature was above zero. This subject was fully discussed by Messrs. J. D. Hoffman, G. D. Hoffman, Donnelly, Blackmore, Berry, Macon, and C. B. Thompson.

Several topics were presented for discussion at this session, but they received little or no discussion.

President Mackay: Has any one made tests on the transmission of heat through concrete walls? (No response.) I know of some heating contractors who have had a very sad experience because of not having data on this subject.

The committees were appointed late in the season, purposely so, and I think they can get results better after the stimulus of this meeting. There are one or two very important committees: one, a new committee, covering data on surfaces of heating boilers, all types of boilers, and we expect a thorough investiga-

tion and some results. There will be some important papers at the winter meeting.

We hope you all have enjoyed the sessions and thank you for your presence.

Mr. J. D. Hoffman: I move it is the sense of this Society, because of the courteous treatment we have had from the local committee (Bureau of Publicity) that our thanks be extended to them for their generosity, and that this motion be placed upon the Secretary's record.

The motion was seconded and agreed to.

On motion the meeting adjourned.

List of Members and Guests present at the Semi-Annual Meeting:

MEMBERS.

ALLEN, JOHN K.
ARMAGNAC, A. S.
BERMAN, L. K.
BERRY, EDW. S.
BISHOP, CHAS. R.
BLACKMORE, J. J.
BRADLEY, EUGENE P.
CAPRON, E. F.
CHEW, FRANK K.
CRYER, T. B.
DAVIS, J. H.
DONNELLY, J. A.
DUGGER, J. P.
FORTUNE, CHAS. W.
GATES, H. T.
GRAHAM, JOS.
HALE, JOHN F.
HOFFMAN, GEO. D.
HOFFMAN, J. D.
JOHNSON, WARREN H.
JONES, A. O.
KAUFFMAN, SAMUEL.
KNICKERBOCKER, J. P.
MACKAY, JAMES.
MACKAY, W. M.
MACNICHOL, F. F.
MACON, W. W.
MARTIN, H. S.
OLDACRE, C. E.
SCOLLAY, U. G.
STACKHOUSE, R. M.
STOCKWELL, W. R.
WEINSHANK, THEO.
WELSH, H. F.
WHITTEN, H. W.

GUESTS.

ARMSTRONG, H. H.
BANNON, J.
BRAEMER, WM.
CHERRY, L. A.
CORNES, C. H.
ELLIS, F. E.
EVANS, EDW. C.
GORTON, JAS. A.
HENSHAW, M. E.
HUNTER, A. H.
JAROLEUM, E. E.
JOHNSON, WM. T.
KENNEDY, C. B.
KENNY, H. E.
LECOMPTE, W. G.
LILLIBRIDGE, R. D.
MCDONALD, S. F.
MILLER, DAVID.
MORGAN, J. B.
MOSHER, H. L.
NEWKIRK, W.
SEELYE, F. T.
RITTER, ARTHUR.
RUCKEL, J. B.
SCHOMAN, H. J.
SIEGEL, J. F.
SMITH, S. C.
SQUIRES, E. N.
STERN, DANIEL.
THOMPSON, C. B.
WHITELAW, F. S.
WRIGLEY, WESTON.

CLXXXIX.

REASONS WHY THE SCIENCE OF HEATING AND VENTILATING ENGINEERING SHOULD BE OBSERVED.

BY J. D. HOFFMAN.

(Member of the Society.)

1. *General Requirements.*—The science, if such it may be called, of heating and ventilating engineering, is one that is founded almost completely upon the laws of thermodynamics. It is not what one might call an exact science, but, in its rational design and application, the engineer may work with a reasonable degree of exactness. Most of the points of interest in the subject may be theoretically developed, yet, as in all branches of engineering design some parts require theory modified by good judgment and the personal equation of the designer. In such cases empirical data, found by tests upon similar apparatus, are not only good things to apply as checks, but at times are absolutely necessary because of the lack of any rational information on that part of the subject. Fortunately, such cases are the exception rather than the rule, for with the properly applied principles of thermodynamics there is scarcely any part of the subject which is not possible of rational solution. Because of the fact, however, that some features of the work are as yet empirical and not as definitely understood as they should be, this is no reason why those who install heating and ventilating apparatus should disregard *all* laws and feel justified in installing a job that is empirical in all its parts, and one which shows scarcely any of the earmarks of theoretical investigation. The time has surely come when it may be demanded of all men who install such apparatus that they follow closely to fundamental principles and be prepared to furnish proof for any step taken in their work.

2. *Letting of Contracts.*—Contracts for heating and ventilating apparatus usually are let in one of the four following ways: (*a*) Some person, called for convenience the *dealer contractor,*

draws up a rough layout of the work, guarantees to install satisfactory apparatus for a stated amount of money, buys his apparatus from the manufacturer, installs it according to his own personal ideas, or according to the plans laid down by the manufacturers, and in a general way guarantees it to give good service; (*b*) a manufacturing firm draws up a plan and contracts to install, for a stated amount of money, satisfactory apparatus, usually made by the same company, guaranteeing its successful operation; (*c*) a responsible engineer is retained, who draws up plans and specifications for the work, and, upon competitive bids, the successful contractor installs the apparatus in accordance with these plans and specifications, the engineer being the judge of the quality of the work and materials; (*d*) a responsible engineer designs the system and assumes all the responsibility in its erection, looking toward a certain required output or result. Materials are purchased in the open market and installed to his satisfaction, and after completion, if the final tests are acceptable, the purchaser pays the bills and takes charge of the completed plant. The last method is not much used in heating and ventilating installation as yet, being confined largely to power and manufacturing plants where a certain definite output of finished material is desired, and will not be further discussed; methods (*a*) and (*b*) being applicable to small installations and (*c*) to larger and more important ones.

3. *Residence Heating by Furnaces.*—Of all the uncertain and *rule-of-thumb* installations, probably the furnace heating of residences can claim the greatest share. Competition among the furnace manufacturers has been so great that we have the country flooded with furnaces ranging in quality from good to positively bad. In order to place the furnaces, it has been the desire, and this is a legitimate one, to simplify construction, to remove features not absolutely necessary, to cheapen manufacture, and in many cases to so rate the furnace that the claims could be realized only under the best conditions of installation, such as would be expected under test conditions and not under conditions as found in average service. Of the above mentioned points, the last one should not obtain in any case, since a furnace should be so rated as to realize its claims even under somewhat unfavorable conditions and the other points should hold good only in so far as not to develop an inferior type of furnace.

4. In addition to what has been said about the furnace, it is also true that the furnace manufacturer has been *so busy cheapening his product* and *placing orders* that he has been selling to Smith, Jones and Brown to install according to their own notions of engineering work, and has not had time to investigate the engineering reputation of Smith, Jones and Brown to see if they would probably bring credit to his firm, nor has he had time to keep his own finger upon the pulse of the job to see if the plant is working well after it is installed. This apparent indifference of the manufacturer to the final results is probably the greatest source of trouble, and is that which gives color to the public mind and decides the buyer against furnace heat, because, as he has some right to argue, " Furnace plants are usually installed so as to make them inferior and defective, consequently the system is in itself defective. It is fast becoming a fact that the correct furnace job is the exception rather than the rule, and some remedy should be applied very soon. The fault is not in the system. Furnace heating, if properly installed, is healthful, cheap and scientific. Neither can it be said that the fault all rests with the manufacturer. The purchaser is to a certain degree to blame, in that he is willing to let the contract to any one who cuts to the lowest price regardless of the quality of the man who takes the contract or of the apparatus which he represents. In certain localities it has become almost impossible for a man of reputation and integrity to obtain a contract, because he expects to live up to the " full intent and meaning " of the contract, and proposes to stay with his work until it is fully satisfactory, regardless of cost. Such a man usually presents an estimate that is sometimes considered high when compared to some others, but when the expense of changes and repairs is taken into account it would in many cases be the cheaper proposition.

It does seem unfortunate that there are men in the business who are in it *exclusively for the dollars*, and care little as to the results. If such men were held strictly to the satisfactory fulfillment of the contract, even though it were to the substitution of an entirely new system, there would be less careless and haphazard bidding, and part of the troubles at least would be remedied.

5. Another phase of the heating business which is a frequent source of annoyance and error is the relation of the heating engi-

neer or the contractor installing such work to the architect. The house plans are usually made without the consideration of heating; the heating plans are then supposed to be made to fit the house plans. Now the average architect knows little about the heating business, but he often thinks he does, and consequently there is set up a different viewpoint between the designer of the building and the designer of the heating apparatus, much to the discomfort of the latter and to the detriment of his work in many cases. To be just to both, the system of heat should be selected first and then allowances should be made in the building plans for its installation. This is no hardship to the architect, since many slight changes, any one of which would possibly be in favor of the heating engineer, may be made in his plans without causing any trouble. Some of these points may be mentioned as follows: The size and location of the chimney; the running of the cellar partition walls to accommodate the location of the furnace and the coal bin; the height of the basement ceiling to allow sufficient inclination of the leader pipes; the construction of the partition walls between the rooms to allow for riser pipes of sufficient size to heat large upstair rooms; the planning of the walls to avoid horizontal runs of heat ducts in the second floor to reach a room otherwise inaccessible; and other points not necessary to mention.

6. All heating engineers know that the range of location of a furnace relative to the house plan is very limited, and that in many cases it is an absolute necessity, after the house plan is completed, to set the furnace out of this desired location, thus compromising the efficiency of the system; also, that the basement ceiling in many cases is so low that the leaders require to be run nearly horizontal, thus reducing the draft in them; also, that a 6-inch studded wall in many cases could easily have been substituted for the 4-inch, with little additional cost, and have improved the system immensely; also, that certain walls absolutely prohibit the running of stacks to the desired spot in the room, and that with a slight change, this could have been arranged without in any way injuring the architect's plans. Such in brief are some of the troubles that the conscientious heating engineer or contractor faces when he proposes to do his work after the building plans have received the O.K. of the architect.

7. Finally, however, the purchaser himself occasionally offers

objections to the proper design of the system because of the desire to economize, although false economy it may prove to be in the end. Occasionally one hears the advice, "Don't heat the chamber rooms on the second floor very warm, because I like a cold sleeping room." Advice which, if heeded, would be good nine times in ten, but the tenth time when it is needed, it is needed badly, and the system and the man who installed it are both censured. How much better to have made the job right at first and permit the owner to regulate the damper to suit his needs, even to closing it entirely. The only word that could be spoken against this way of doing things is because of the very small increase in first cost; on the other hand, the favorable comment would be: "A system that is correct and one that *will heat* if you want it to." Good advice to all men installing residence heating systems is, "Heat every room as though it were to be used as a living room, and let the owner regulate to suit his needs."

8. *Residence Heating by Hot Water and Steam.*—Not so much can be said about the failures in *hot water and steam systems,* because, as a rule, they are planned with greater care and by men better qualified to do the work. However, of all the difficulties experienced in both systems, by far the greater part can be charged to the hot water work. This is to be expected, when one remembers how very small is the motive force causing circulation in the water and how easily this may be counteracted by small pipes, many short turns or improper laying. Short cut rules for proportioning radiation are, also, in too frequent use even by those well grounded in the subject, and from whom could be demanded a more rational course. Residence heating by hot water and steam is fairly well standardized, and if designed from fundamental laws and principles, and installed with care and good judgment, should in every case give good results. Some of the points wherein these systems give trouble are as follows: Chimneys too small; heater or boiler too small; heater or boiler too far from chimney; heater or boiler set too high, thus giving too little pitch to the main piping; mains too small, thus killing the flow of the water and steam, also bringing the water line of the boiler too near the level of the lowest radiation; radiation too small and improperly placed; and other minor points.

9. The architect is responsible for the location and capacity of the chimney, and, in a degree, to the location of the heater or

boiler, for, as he plans the basement, the heating apparatus must be located to suit. Many chimneys are poorly located and are of improper size, and when the heater or boiler does not fire well the responsibility of the architect in the matter is seldom thought of, and the censure is placed upon the shoulders of the man who installed the heating apparatus. This feature of the work is where the heating engineer can do some missionary work in the line of architectural design. The other points mentioned are directly chargeable to the man who designs the heating system, and there is little excuse for his mistakes. All should know that the surface of mains and branches should be counted as radiation surface, and that the efficiency of the heater or boiler is somewhat reduced after having been in service for a time. Because of this latter point, a selection would be made having a capacity about 25 per cent. greater than the total radiation found. When such a generator is properly set, all pipes in the system will have a satisfactory fall, the minimum height of circuit will be sufficient to cause a good circulation, and the pipes will be so proportioned and attached as to avoid short circuiting or water hammer. Too small mains on a steam system have a tendency to force the water on the return end back into the radiators and cause "flooding." All of the above points, and still others that might be named, will stand as a credit or discredit to the designer.

10. *The Heating Engineer and the Contractor.*—In installations calling for a large expenditure of money, the heating engineer is usually called in to draw up the plans and specifications, and the contract for purchasing and installing the plant is usually given to a separate party. This has the advantage of obtaining the complete layout of the plant with the apparatus specified by a party who is in a position to give an unbiased opinion, and also the advantage of obtaining a low estimate on installation because of the competitive bids. This system seems to be a very satisfactory one, all things considered, and probably gives the best results to the purchaser. It is not, however, entirely free from abuses. It is assumed that the party retained to do the engineering work will do his work conscientiously and scientifically, and that when done each part will correlate to the other parts and all will work in harmony and without loss of efficiency. This means that the designer himself should understand his subject and should be able at any time to give facts and figures on every part

of the work. He should also have his plans and specifications complete in all parts and stated in plain and definite language, so that the contractor will understand every part and not be compelled to assume conditions which in the end may be erroneous. No uncertainty should enter into any part of the contractor's work, either as to quality and make of materials, or as to the way in which such materials are to be installed. Of course, there are many features of the work which may be left open to the discretion of the contractor, and these should not be arbitrarily stated. Such parts as the smaller details of the piping system, for example, where the cutting of the various parts may not in the least affect the efficiency of the plant, and where purposely omitting the same in the specifications and plans will give some latitude and satisfaction to the contractor in his work. These and other minor points are best not specified. The great trouble, however, with plans and specifications is not as to their exactness even to every little unnecessary detail, but as to the *lack of exactness concerning important points.* When the contractor may reasonably make more than one interpretation of any certain part, it is naturally to his interest to take such view of the case as will carry out the letter of the contract at the least possible expense. This may not be to the best interest of the purchaser, but such procedure should not be wholly charged to the contractor.

11. The final word of caution that this paper wishes to extend probably does not apply to any member of this organization, but it does apply in many cases to men in like occupations with yourself. The keynote is struck in the preceding paragraph and may be paraphrased in the following: "The engineer attacking any important problem should first become thoroughly familiar with the principles involved in its solution, and should afterwards check his results wherever possible." This point was emphasized to the writer in a test recently run upon a heating and ventilating plant in a certain building used for auditorium purposes. The trouble in this plant seemed to be not the one usually found—*i.e.*, cutting of parts to a minimum size and capacity—but rather the reverse, as will be seen by only one item out of a number which might be used for the benefit of illustration. The auditorium, which was exposed on two sides, contained 225,692 cubic feet of volume, and was designed to accommodate 1,350 persons, thus requiring, we will say, a total of 2,430,000 cubic feet of fresh air

per hour. Allowing the outside temperature to be zero and the temperature of the auditorium air to be 65 degrees F., the total heat loss, including that thrown away with the air, was found to be by calculation 3,072,875 B. T. U. per hour, which gave by calculation 2,375 square feet, or 7,125 lineal feet, of one-inch coil surface in the indirect heater. When the coil surface was measured after the test, it was found to contain 14,612 lineal feet, or a little more than twice the calculated amount. One reason for the test was the fact that a large part of the coil surface had been shut off soon after installation and never used afterward, and it was supposed that the system was not well proportioned. Other parts of the plant also seem to show the same lack of rational design.

12. What has just been stated concerning this one plant is true of too many plants about the country. If the business we represent is to rank high among other lines of engineering work, it is the duty of every man to discourage such methods and insist upon a higher standard.

DISCUSSION.

Mr. Chew: I want to say one thing about the correctness of these comments. The business has got in such a condition that the manufacturers have got together, and are engaged at the present time in an uplifting movement, and it is to their advantage to prepare a handbook that they may have some guide. While the statement is often made that a little knowledge is dangerous, that is no reason for withholding knowledge from those who need it. The Federal Furnace League is having prepared a handbook for that purpose. Some sort of rules must be given to the men who are going to do the furnace business in the future, or they will do it the same as in the past. These men, unfortunately, have not the influence with the architect and others who design the buildings which will induce them to change their methods of designing so that air can flow without friction or obstruction from the place where heated to the place where needed, and maintain a comfortable temperature. The man who works in overalls is in good shape to do the mechanical work, but not to influence the architect. He cannot secure larger and better-shaped flues from the architect, nor can he induce the

woman to change the arrangement of her furniture so that the register can be put in the place most advantageous. Those who know and can convincingly present the facts have a duty to help the trade and uplift the business. I hope the Society will be able to contribute something along the lines suggested.

Mr. G. D. Hoffman: There is an old saying that you can lead a horse to water, but you cannot make him drink.

We go to a great deal of pains and expense to carefully prepare directions for the proper installation of specialties which we furnish. We put a copy of these directions in every box containing two of these valves.

Last fall I was called up on the telephone by a certain steamfitter who said he was having considerable trouble in properly installing the valves. He asked me to come out to the job and instruct his workmen how to properly finish the work. After I reached the job I asked the steamfitter if he had carefully read our directions for installing the valves. He replied he didn't know anything about any directions. I said there should be a copy of directions in every box containing two valves, and asked him where he had unpacked the valves. We went to the room where his helper was unpacking the valves, and all over the floor were these direction slips, and picking up one of the slips I said, "Here is an answer to every question you have asked. Didn't you read these directions?" He replied no he hadn't, and he hadn't, in spite of the fact that on the outside of the slip was printed in big letters, "Directions for Installing—Please Read Carefully." The result of his negligence in this direction was that he had a great deal of his work to do all over again.

Now the architect in this particular case had specified how this job was to be done and what appliances were to be used, and had gone more or less into detail, but no supervision was given the job in any way. The architect paid no attention to it to see whether his specifications were followed out or not.

Now I would like to ask how are we going to compel the contractor or steamfitter to absorb a little of the information that we, who are specialists, possibly have taken years to prepare.

President Mackay: The only answer is "dissemination of knowledge." It is true that we are all apt more or less to disregard ordinary, plain instructions.

Mr. Davis: See that the engineers superintend their work.

Mr. Gorton: I find supervision varies in different sections of the country. Some men know it all. You cannot tell them anything. A man laid out a certain job requiring certain specialties. The steamfitter took the plans to bid on the job. It was pointed out that this was to be done so-and-so, and he said, "Yes; I see all right." He rolled the plans up and took them to his office and put them in his desk. The steamfitter goes to work to do an ordinary job as he understood it, following out his own ideas. Needless to say when the job was put up it did not work, and he was immediately sent for. He was asked right away where were the plans. He hunted around. "I haven't seen any plans." At first he denied all knowledge of any plans. At last he went to his desk, opened it up and pulled out a roll of plans. There everything was marked as plain as could be. The only thing he followed was the location of the radiators. Everything else was wrong. Result, nearly all the piping has to be ripped out and done over again, and the boiler taken down and a pit dug about eighteen inches deep.

On other jobs plans and specifications have been furnished and followed out to the letter. We have had a good deal of trouble with the indifference of the steamfitter.

Mr. J. D. Hoffman: If you touch a man's pocket-book you are going to set him thinking quicker than in any other way. So if a contractor deliberately ignores instructions he should take the work out and do it over again. Too many times a man is permitted to put in a job and leave it go always as a defective job. When it is done incorrectly and not according to plans and specifications, pull it out and make it right.

Mr. Oldacre: The manufacturer of heating apparatus is the greatest disseminator of knowledge concerning apparatus there is. He is the man who gives the general public the rating his apparatus is supposed to carry. The heating contractor is the one who has to fill the contract. The architect is the man who stands to the front and is supposed to be responsible for the plans. But they are designers, artists, and when it comes to the question of mechanical details they have to call on other people. The heating engineer, as an engineer, is not as well recognized a factor as he should be and as he ought to be.

Secretary Mackay: It seems to me the man who makes the plans is the best man to interpret them. He sends them to the

steamfitter to follow out and says nothing further until the apparatus is completed, when he finds they have been misinterpreted or ignored altogether, as in Mr. Gorton's case. The heating engineer should furnish supervision over plans and specifications, and condemn the work during its progress and not at its completion.

Mr. Oldacre speaks of the architects. Our Society some years ago appointed a committee—Mr. Jellet, Mr. Adams and Prof. R. C. Carpenter—to confer with a committee appointed by the American Institute of Architects. They were well received by that society, and ideas were given and taken. I want to say that the best architects in the United States to-day recognize the necessity of employing engineers outside of their profession when it is necessary in the construction of a building. The architects are an intelligent body of men, and will work with sense and reason with any engineering body, and it is wrong for us to put anything in our records that would imply anything different.

Mr. Chew: Tell a man what you want him to do. It is a fact that if you give to any man a rule he will apply it according to his reason. If he has no rule he will make a mess of it. What is needed is not so much a statement of the complaints or troubles, but a description of the remedies that removed them. The heating engineers should tell how they got over troubles —what can be done to avoid them, how to make the house warm. Give something that can be taken home and tried, so that at the next meeting reasons and explanations can be given. Then out of this counsel some wisdom will come.

CXC.

A HOT AIR FURNACE IN A HOUSE WITHOUT A CELLAR.

BY R. S. THOMPSON.

(Member of the Society.)

Some time since I was asked if I could put a furnace in a house where there was no cellar, and where, on account of local conditions, a cellar was impossible.

I replied that it *could* be done, and I submit herewith a sketch showing how it *was* done.

The house had six rooms, four in the first story and two in the second, the rear being only one story high. As the two halves of the house were much alike, a sectional view of one side shows practically the whole. The dimensions of the rooms are given on the plans.

I had the owner build a small shed room in the rear, so that it extended across part of each of the back rooms, as shown in the first floor plan. In this the furnace was set opposite the central partition, so that one-half the furnace was back of each room.

A rectangular pipe 12 x 14 inches, made of galvanized iron, was placed under the ceiling of the rear room, against the inside wall, and carried through the wall into the furnace room over the furnace, with which it was connected by a 14-inch upright round pipe.

A register in the side of this rectangular pipe, as shown in the elevation, heated the room through which it passed. Close to the ceiling in the front rooms wall registers were connected with the end of the rectangular pipe. An 8-inch round pipe was tapped into the top of the rectangular pipe near the front of the room, carried through the loft and into a register in the wall of the front upper room above the baseboard, as shown.

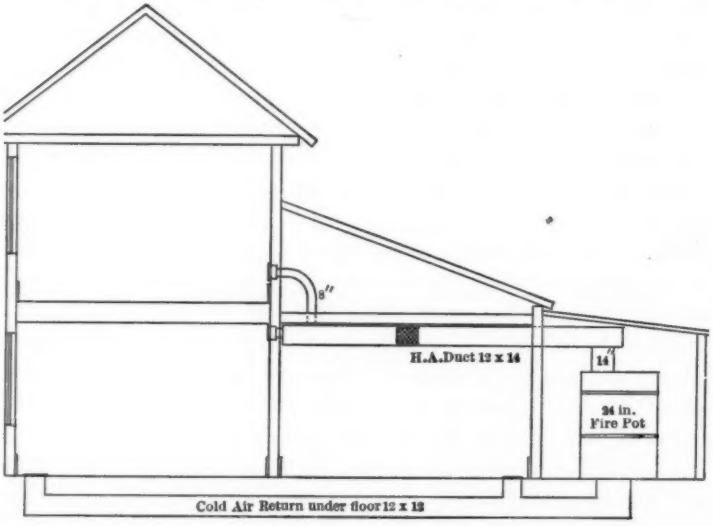
The two lower rooms and the upper room on the other end of the house were handled in practically the same manner. There were thus two 14-inch pipes taken off the top of the furnace to

XUM

heat these six rooms, the two having an aggregate area but little greater than that of six 8-inch pipes. But I have found that one 14-inch pipe will carry more air than three 9-inch pipes, and a pipe rising perpendicularly off the top of a furnace will carry much more air than a horizontal one.

Of course this put an exposed square pipe in each of the back rooms, but as it was against the ceiling and the wall it could easily be incased, and did not materially mar the appearance of the rooms.

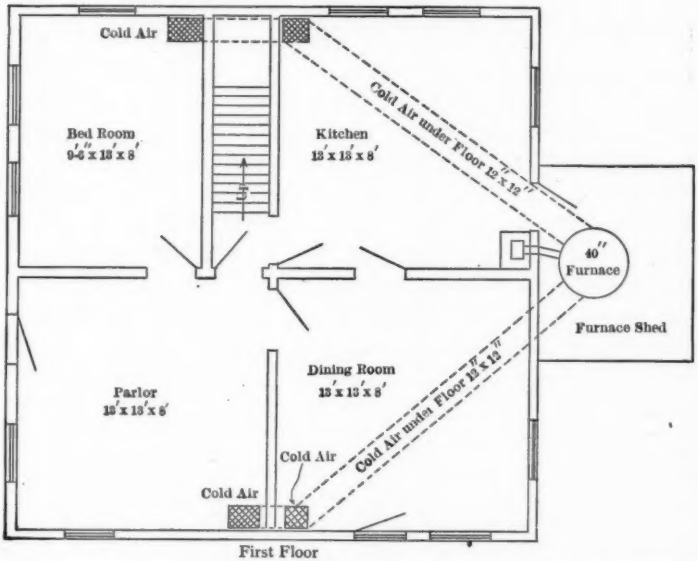
The elevation and plan were originally laid out as shown for



return air ducts under the floor, connected with cold air registers in the four lower rooms and with the furnace. Owing to some changes in the plan, these have never been put in, and as the system is working to the delight of the owner, it is probable they will not be, though it is certain they would greatly improve the working of the system.

This particular job was a makeshift, adapted to existing conditions, and it was put in an old house which would not warrant expensive changes in the building; but anyone can see how easily the plan could be adapted to other houses, if it was worked out before the frame was up, especially to the ordinary eight-room square house.

In such a house the second floor joists could be laid from the front to the back of house and four rectangular pipes could be carried between these joists and out into the furnace room, each pipe heating one first floor room with a ceiling register, and one second floor room with a floor register. The area of each of these ducts should be at least 25 per cent. larger than the combined free outlet of the registers supplied, and the register at the ceiling of the first floor room should be much larger than the register in the floor of the second floor above it.



First Floor

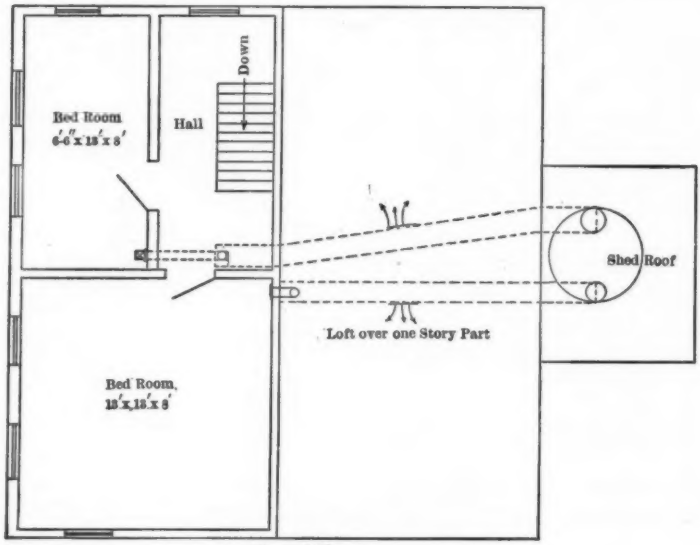
Ducts for the return of the air to the furnace could be carried between the joists of the first floor rooms with a cold air register in the floor of each of these rooms near an outside wall, and I should consider this a very important feature of the system. In my judgment the combined area of these return ducts should be at least 90 per cent. of that of the hot air ducts.

A little mechanical common sense will suggest modifications which will make this plan applicable to houses of other sizes and other construction. The important point is that the plan would have to be worked out before the construction of the house was commenced, and the carpenters would have to accommodate their work to it.

This system has several advantages.

There is no running down into a dark cellar to attend to a furnace. The floor of the furnace room can be on a level with the floor of the house, or not more than one or two steps down. It should, of course, be made of concrete.

The walls could be of brick, or frame, covered with galvanized iron. The top of the furnace would be so far below the roof that there would be no danger from overhead heat. It would undoubtedly be safer from fire than the usual plan.



Second Floor

There could be abundance of light, and consequently this furnace room could be kept much cleaner than the average furnace cellar is kept.

If the furnace were one with large "thoroughfare" (clear space inside the casing) and air ducts, both flow and return were of ample size, air could be used at a comparatively low temperature, which would improve the air in the house and prolong the life of the furnace.

While there are other reasons which make it improbable that this plan will be adopted to any considerable extent where cellars are possible, yet there are some localities where cellars are impos-

sible, and in nearly every locality there are some houses where a cellar is impossible, and this plan may therefore extend the usefulness of the hot air furnace.

A furnace with a 24-inch firepot was used, because a second-hand furnace was available, and not because so large a furnace was necessary, as it had previously been used with satisfaction in a house of ten rooms.

DISCUSSION.

Mr. Jones: In defence of Mr. Thompson's plan, of taking the cold air from the outer wall of the room and not from the extreme front, that is, not from the farthest point from the furnace, it is my experience that the results will be more satisfactory in this case. Some members present will remember the paper he read in Chicago, I think two years ago, in which he told us of doing something, I think no man living in the heating business was ever able to accomplish, except Mr. Thompson. He carried air something like thirty-nine feet through a perfectly horizontal pipe and heated a large, exposed room in a church. Fearing this Society would get that paper on its records without discussion, I took the liberty of challenging the possibility of doing this. If he were here I would feel like saying more on this subject. But I will say that in my experience I have found it possible to heat rooms near the furnace on the same level by delivering the air at the top and removing it at the bottom of the room.

CXCI.

SIMPLIFYING THE INSTALLATION AND OPERATION OF SCHOOL HEATING AND VENTILATING APPARATUS.

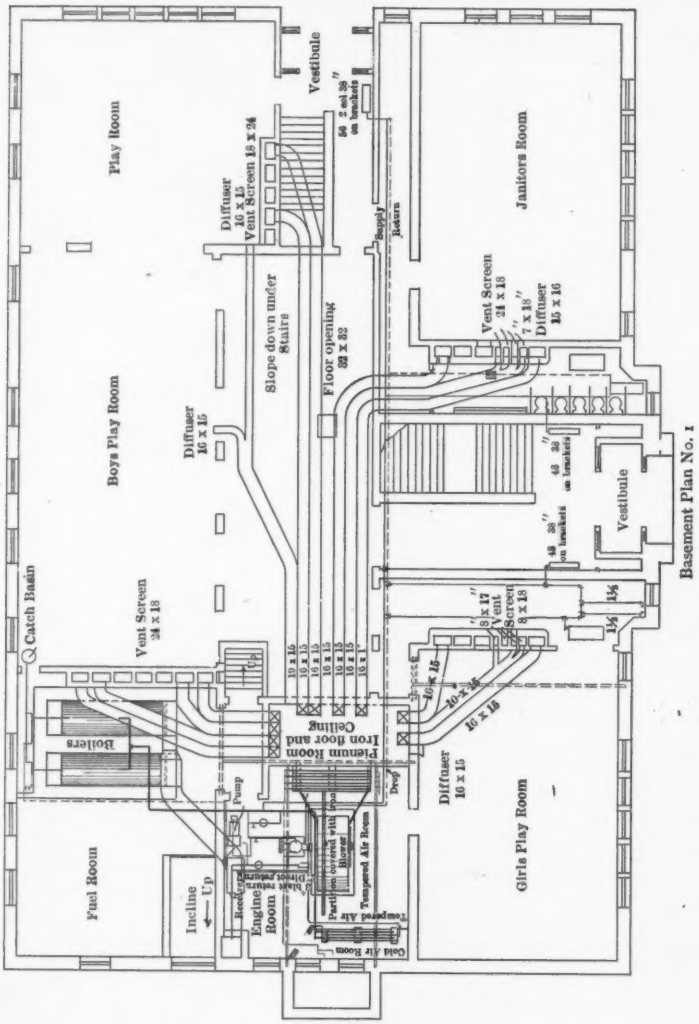
BY S. R. LEWIS.

(Member of the Society.)

If there is any such thing as a standard type of blast steam heating and ventilating apparatus for school buildings in this country, perhaps the plant shown in the accompanying plan and marked No. 1 may be described as standard.

The boilers are of the ordinary horizontal return tubular type, and are operated at comparatively high pressure. The fan is engine-driven, and the exhaust steam from the engine is used in the heating system. The customary pressure-reducing valve, back pressure valve, grease extractor, etc., are installed. The water of condensation is returned to the boilers by an automatic pump and receiver. The air is tempered for cooling the building by approximately one-third of the total heating coils prior to admission to the fan, and heated for warming the building by the remainder of the heating coils set at the fan outlet. This system, when carefully designed and intelligently operated, is probably more economical in operation than any other. If, however, for any reason the fan cannot be operated, the warm air will all go to the nearest and warmest rooms, and those with the greatest exposure and longest horizontal ducts suffer. This possibility has led in many instances to the installation of direct radiation as an auxiliary to the fan system.

If there is not a separate duct and mixing damper for every room, enough direct radiation must be installed in each room to heat the same independent of the fan, else the temperature of the building cannot be controlled. This leads to a heavy first cost, for practically two plants, the ventilating system costing very nearly as much as an all-blast system, the direct radiation being additional.



This plan is also subject to the following objections:

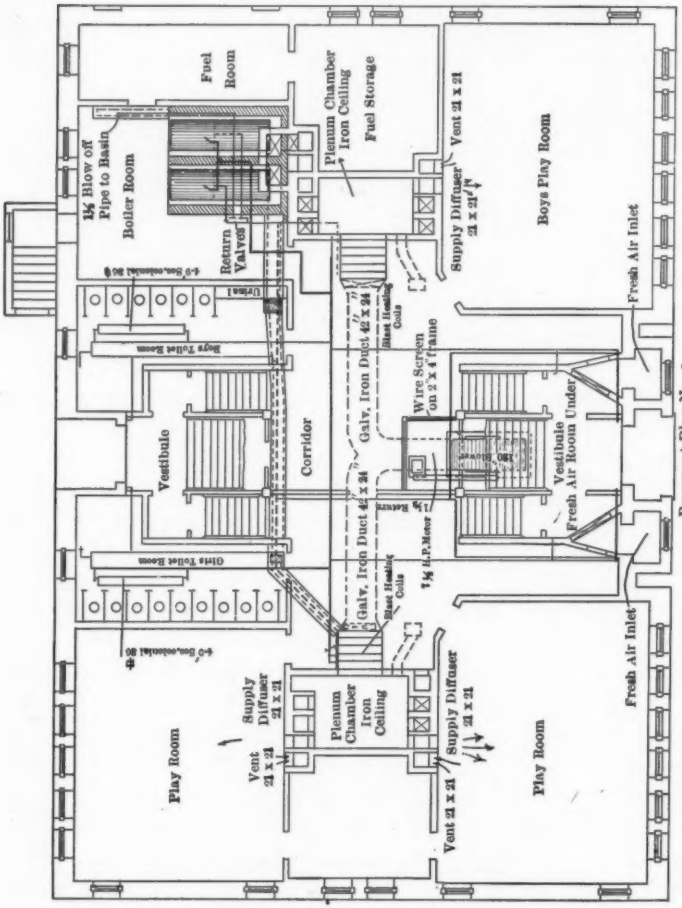
The direct radiation is constantly pumping foul air and dirt from the floor and mixing it with the fresh air at the ceiling.

The direct radiation causes local overheating and occupies valuable space in the rooms.

Well-authenticated records show that the combination plants

above described are considerably more expensive in fuel than the all-blast plants, and it is evident that they must require more attention and repairs.

The above reflections led to the development and installation



of a number of plants of the type shown on plan No. 2, which seem to overcome the main objections to both of the previously described systems.

This type is subject to many modifications, and I do not claim that it should receive consideration over the old types in every

instance. I know, however, that for many installations it will give superior results. There is nothing especially original about it, it being merely an adaptation. It is easy in many instances so to locate the flues that it can be economically installed.

The boilers are set so that the difference in level between the base of the blast coils and the boiler water-line is about thirty inches. The coils are located in small plenum chambers at the bases of the flues. There is practically no direct radiation. The fan is motor driven. The steam pressure may be anywhere from 0 to 20 pounds, or higher. The circulation is entirely by gravity. The air is tempered for cooling the rooms by double dampers in the plenum chamber decks.

When the fan is stopped the rooms get a good flow of air by gravity, and are heated almost as efficiently as by direct radiation, while securing considerable ventilation. If any gravity furnace plant will heat, this steam plant will do so by gravity. The steam-fitting is a trifle more expensive than with the first type, but infinitely less expensive than with auxiliary direct radiation. In many buildings this apparatus may be laid out with better economy of space than with any other type. It retains the advantages of the older apparatus and eliminates the faults without incurring the disadvantages of the still older type of blast plant in which the indirect radiation for each room is located in the flue leading to that room.

In engine-driven plants the layout is the same, care being taken that when the engine is not running the pump may be by-passed and the blast coils circulated by gravity. To this end, of course, a low water-line boiler and shallow blast coils must be used.

The steam piping must be generously proportioned, so as not to have an undue false water-line. Tests with a water glass on the return drop from a blast coil 75 feet from the boilers indicated that when the fan started, blowing air at 8 degrees below zero, the water stood about 26 inches above the boiler water-line, but soon settled down and remained constant at about 18 inches above the boiler water-line.

Wherein this plant fails to deliver results equal to the older types is not yet evident to me after two winters' experience and observation of several installations.

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FURNACES WITH FANS.

There will probably always be a large number of school buildings heated with furnace apparatus. Anything like the same engineering skill and research as have been devoted to steam heating extended along this line would have given it a far better reputation to-day than it holds. The general availability of electric power, and the compulsory ventilation requirements, have given fan furnace heating a great impetus. The following seem to me prime considerations:

There is almost no furnace well adapted to any one fuel which is of much account for any other fuel.

Radiant heat does not warm very much air, and the heat from a furnace is largely radiant heat, which rises in great quantities directly upward from the fire. The most efficient furnaces will be found to have great weight of metal suspended above the dome, so arranged as to absorb the heat and transmit it by contact with the rising air currents.

Because of the high air temperature possible, many furnace plants have been made to worry along with disc fans of inadequate size and poorly proportioned ducts. The same size and type of fans and ducts should be used interchangeably for blast steam or blast furnace apparatus, if adequate results are to be obtained.

Blast steam plants have valves for control so that one or more sections of the heating coils may be cut out as the weather conditions permit. With adequate fan capacity, speed regulation, and properly arranged compressor dampers above the furnaces, which are grouped, one or more may be cut out and not fired, sufficient air for ventilation being forced at an increased velocity through the casings of those in use.

Blast steam plants are almost universally equipped with automatic regulation. Blast furnace plants may be controlled with equal facility and tempered air be secured for cooling the rooms without difficulty by using dampers in the plenum chamber decks.

For hard coal great fire-box capacity and shaking and dumping grates are imperative. Apparently the weight of the furnace is not as vital as its coal storage capacity.

For soft coal, however, the furnace must have great weight of metal to store to some extent the heat from the quickly flashing combustible, and to prevent the rapid changes in temperature of

the building in effect when soft coal is burned in a light weight furnace.

All furnace fan systems in large buildings are subject to the objections to steam plan No. 1 previously described. It is doubtful if adequate furnace fan systems can be installed more economically than equal steam systems in buildings containing over twelve class rooms. For smaller buildings the horizontal pipes are usually not so long, but that some gravity circulation is in effect when the fans are not running. The toilet rooms may profitably be protected from freezing by very small auxiliary direct hot water or steam plants, the fires in which are never permitted to go out in freezing weather.

Fan furnace plants along the lines herein outlined will give very good results as to efficiency and economy. Very many of these heating systems will be installed. I ask for them more study and engineering skill than they have had in the past. The field for improvement is almost unexplored.

The internal combustion engine is rapidly supplanting the steam engine. It may well be that we will see the day when the direct acting air heater shall supplant the steam boiler and coils.

I have attempted to describe a steam plant which has proven as simple and easy to operate as any furnace plant, and to describe a few refinements in connection with furnace plants which have proven greatly to increase their economy.

DISCUSSION.

Mr. Weinshank: Mr. Lewis not being here I cannot ask a pertinent question. I would like to ask whether some one here present understands the statement made in the first paragraph, wherein he says, "The plant shown in the accompanying plan and marked No. 1 may be described as standard." Does he mean standard design?

It has been my experience in blast work that only in one chance out of a hundred the designer will place the fan in one corner of the building, unless he is absolutely compelled to do so. You will invariably find in old plans where blast heating is used, the fan is centrally located in the building or centred at one side of the building, but never at the end. If he meant by

the word "standard" that which is considered to be a model, then Mr. Lewis contradicts himself later on when he gives many objections to his design. He stated that furnace heating in large buildings is subject to the same line of objection as No. 1. In other words, he does not consider Plate 1 as standard or good.

President Mackay: I believe Mr. Lewis calls the plan shown on Plate No. 1 "standard," not because of its location in the building, but because the fan, tempering coils and reheating coils are arranged in the manner almost universally used where it is intended to deliver either hot or tempered air to the various rooms. He wishes to bring out the distinction between an arrangement having the heating coils close to the fan with long hot-air pipes leading to the rooms, and an arrangement having the heating coils near the rooms with long cold air pipes between the fan and the heating coils.

Mr. Johnson: The furnace man generally instals the same way as in No. 1 and the steam-fitter as in No. 2. You can instal the furnace at one end of the building and convey the warm and cold air in ducts, locating the furnace near the flue. Many times you can operate the furnace by gravity.

President Mackay: Is that very efficient?

Mr. Johnson: I have worked it for seven or eight years and very satisfactorily.

President Mackay: Are the furnaces examined periodically to see what condition they are in?

Mr. Johnson: Yes, sir.

Mr. J. D. Hoffman: What kind of furnaces?

Mr. Johnson: Long furnaces with immense heating capacity and very heavy. Mr. Lewis mentions their being very heavy. These furnaces weighed about six thousand pounds each, all in one battery near the centre of the building.

Mr. J. D. Hoffman: Have you ever had any experience as to consumption of fuel with the hot-air furnace and a steam blast plant?

Mr. Johnson: I found the fuel consumption was less than with the steam. I am not an advocate of the furnace blast system. The only reason the furnace blast plant is installed generally is because the first cost is less. For instance, where a steam blast system would cost $6,500 or $7,000, the furnace blast system would cost about $5,000.

Mr. J. D. Hoffman: Where you made these tests were there many furnaces in the battery?

Mr. Johnson: Yes.

Mr. Weinshank: I fully agree with Mr. Johnson in one statement. The reason the furnace is being used nowadays is because it is cheaper. The man who builds a small residence to-day invariably says: "I wish I could afford to put in a little steam or hot-water plant, but I cannot afford it."

My experience in heating dates back since 1892, and there are a few members present here who have been in the business, or studied the problem of heating long before, and they will agree with me when I state that when Mr. Lewis says: "It may well be that we will see the day when the direct air heater shall supplant the steam boiler and coils," that he hopes against hope, for the reason we see every day the furnace is becoming a thing of the past, the same as the old reliable wood stove and fire-place. Now, why? It is cheaper to put in a stove, and cheaper to put in a fire-place than a steam plant. Why do we put in a steam plant? Because we have learned by experience it is cheaper to operate a steam plant than a furnace plant. I have had experience in days gone by to get in competition for large school-houses against furnaces, that is, we were bidding on a steam plant in connection with fan and coils. Bids also were taken for the same building for furnaces with blast. Of course the prices were greatly different, as Mr. Johnson stated. It was often a question whether the school had money enough to put in steam. If they had money enough they put in steam, because they learned by experience in seven or eight years that the difference in the cost of operation would pay for the plant. I am sorry to see Mr. Lewis, who has had experience in heating, hope that the steam boiler will be supplanted by the furnace.

Mr. Kauffman: Furnace plants are put in on account of the cheapness of the apparatus, and a good deal is made out of it, but I know where quite a number of these plants have been thrown out. I really think these smaller towns in the West are waking up to the fact it doesn't pay to put in that sort of a plant.

Mr. J. A. Donnelly: There ought to be no question about the amount of fuel consumed between the steam and hot-air furnaces. It has been the subject of a good many tests, but I don't think any one can safely say any number of schools will get a

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hot-air furnace after using steam. There might be isolated cases. I think we all know where schools have been tested for heat and ventilation the steam-heated schools have been far superior to the hot-air furnaces. The experience they are going through in the West was repeated in the East twelve or fifteen years ago. The hot-air furnace houses in the East used to sell a great many of their standards, and for school-houses they put in four or eight or twelve.

Mr. Chew: I want to call attention to the fact that Mr. Brady, of Kansas City, supported by Mr. Davis, of the same town, said that in Kansas City almost any kind of a furnace with a fan back was economical and was effective in heating schools. So while you say it is a foregone conclusion that the days of hot-air furnaces are gone, you have other members on record of the opposite opinion. In churches, where four furnaces would be necessary to supply the heat on a gravity basis, more than three are never required when the fan is in use. The reason is there isn't so much waste in the chimney as by the gravity method. What we are after are facts.

Mr. Davis: Mr. Chew quotes Mr. Brady as stating the fan furnace is more economical. I ask why Mr. Brady is putting in exclusively steam blast end fans now.

Mr. Chew: I referred to the Proceedings.

Mr. Davis: He, perhaps, has changed his mind. They are putting in nothing but steam apparatus now.

Mr. Kauffman: And have been putting in nothing else for five or six years.

Mr. Chew: Mr. Brady expressed himself as having experience with fans and getting good results. Whether that system he mentioned was satisfactory for the large building he is now heating is another question.

Mr. J. A. Donnelly: While on the subject of economy of coal and hot water, about six or eight years ago, at Greenpoint, I was asked to look at a five-story building and a large library on the corner. The apartments had never been heated and the library was heated with a hot-air furnace. The Society controlling the building asked me to look up the subject of warming the apartments. I looked over the building and through the apartments, and asked how much coal they had used in the hot-air

furnace. They told me twenty-five tons a season. I gave them a price on heating the apartments. They wanted to know how much it would cost additional to put in steam for the library—they didn't know they cared to change—a boiler large enough to heat the library as well. I told them about twenty-five tons would heat the library and all the apartments. I did a great deal of work for these people afterwards. I do not think they have burned more than twenty-five tons. There was a case of enormous waste. It did not seem possible they could get twenty-five tons of coal burned in that furnace and get the heat up the chimney. It didn't get into the library. There is no doubt about that. How they got it up the chimney I do not know. That is an extreme case.

President Mackay: Maybe a badly installed furnace and a most excellently installed steam plant.

Secretary Mackay: While I am not an exponent of the furnace system, I want to call attention to the fact that in Massachusetts when the State law was enacted the only building that complied with the law was one heated by furnaces. Within the last four or five years I know of a number or good-sized buildings, under the supervision of the district police, where furnaces with fans have been placed and give the desired results and economy. I think it is wrong for us to decide against these facts that have taken place in Massachusetts and are going on to-day in New York State and New Jersey. A furnace if properly made and proportioned to the building will heat as well, but not as economically as steam or hot water.

I was called in a few years ago to a building in New Jersey, with indirect steam for ventilating and heating, an eight-room school building, which burned ninety-five tons of coal a year and had been doing so for five years. They were building twelve additional rooms of the same size, making twenty rooms, and they wanted to know what to do as they could not afford the additional amount of fuel. I designed a steam apparatus for them. The question of guarantee of fuel came up. I could not by any manner of figuring make it take over seventy-five or eighty tons of coal. They asked if I would guarantee seventy-five tons. I said I would guarantee a hundred. They had been burning ninety-five to heat an eight-room building. That build-

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ing is being heated and ventilated according to the State laws of Jersey, the same as Massachusetts and New York, and has been for six years, and the consumption of fuel has averaged sixty-five tons of coal a winter, in a twenty-room school-house against ninety-five tons in an eight-room school—same building. So it is not always the particular type of apparatus.

Mr. J. D. Hoffman: We have been comparing the efficiency of the furnace system with that of the direct radiation steam system. If you supply ventilating air, you must heat it and then throw the heat away when the air is exhausted. A furnace, especially a badly constructed one, is going to take more heat than a good steam or hot-water heater. In making comparisons with steam or hot water systems, the furnace plant should be run under the same conditions.

I want to inquire of Mr. Donnelly if, in the plant he mentioned, they had ventilating air in the steam system; in other words, was it an indirect steam system?

Mr. J. A. Donnelly: No, sir; didn't have any ventilation in the library. Used the open windows and the door. They got mostly coal gas in the library.

Mr. J. D. Hoffman: Did you have any return circulation of air from the library?

Mr. J. A. Donnelly: Yes, sir; the stairway and high ceiling. It went down the stairway to the furnace. The side of the furnace was open and the hot air came up into the library through some immense registers in the floor.

Mr. J. D. Hoffman: I believe that the radiated heat loss from a building is the same no matter what kind of heating system is employed. But where fresh air is added the loss is proportionally greater. When we are dealing with efficiencies of different systems we should insist upon like working conditions.

Mr. Kauffman: Possibly one argument is that the pipes are exposed in places which causes a loss of heat in transmission over long distances.

Mr. Chew: Mr. Lewis says in his paper: "I ask for them more study and engineering skill than they have had in the past." Suppose the furnace men got together and compared a poorly proportioned steam or hot-water system with the best furnace system? You can go anywhere around New York or

Philadelphia and see one house properly heated with a hot-air furnace and another with steam, and it is a farce to waste the time of the Society speaking in disparagement of either system. What we are here for is to get information, and the troubles of the past can only be valuable when they can be used to point in the right direction.

CXCII.

CAST-IRON HEATERS FOR HOT-BLAST WORK.

BY THEODORE WEINSHANK.

(Member of the Society.)

The heater referred to in this paper is made of sections having cored diamond-shaped projections on each side, as shown in Fig. 1 and cut section Fig. 2. The flat sides of the section are

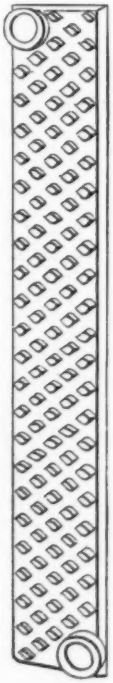


FIG. 1.

FIG. 2.

braced at intervals, so that the metal may be thin and yet the section be strong. It will be seen that the metal is of uniform thickness, hence all parts are equally effective in condensing

steam. The shape of the projections is such that while offering a minimum resistance to the flow of the air, it insures that the stream of air passing over the surface of the section shall be thoroughly broken up and all the air made to come in direct contact with some part of the metal of the section. The sections are fastened together in groups by screw nipples at top and bottom. The length of the nipple determines the amount of free area in the heater. A large free area means a low resistance to the passage of the air at a given velocity through a group of sections, and a low rise of temperature of the air; while a small free area a high resistance to the passage of the air at a given velocity, and a high rise of temperature of the air. As a heater is made up of groups of sections placed one behind the other, it is evident that if we have a low rise of temperature of the air per group of sections we must have a heater of greater depth than would be necessary where the temperature rise of the air is greater. That is to say, a long nipple means a wide and a deep heater. The nipple finally adopted in this type gives approximately 50 per cent. free area, and has proven by experience to give a good temperature rise to the air, as shown on table 1.

TABLE 1.

RISE OF TEMPERATURE, K, PER DEGREE DIFFERENCE BETWEEN TEMPERATURE OF STEAM AND MEAN TEMPERATURE OF AIR FOR DIFFERENT VELOCITIES OF AIR. VOLUME OF AIR MEASURED AT 70 DEGREES.

Velocity, feet per minute.	Number of sections heater is deep.					
	1	2	3	4	5	6
1600	0.124	0.253	0.395	0.527	0.649	0.761
1500	0.132	0.261	0.403	0.535	0.657	0.769
1400	0.139	0.268	0.410	0.542	0.664	0.776
1300	0.147	0.276	0.418	0.550	0.672	0.784
1200	0.154	0.283	0.425	0.557	0.679	0.791
1100	0.162	0.291	0.433	0.565	0.687	0.799
1000	0.170	0.299	0.441	0.573	0.695	0.807
900	0.177	0.306	0.448	0.580	0.702	0.814
800	0.185	0.314	0.456	0.588	0.710	0.822

s = number of sections heater is deep.
v = velocity of air in feet per minute.

$$K = 0.185 - \frac{0.061(v-800)}{800}, \text{ where } s=1.$$

$$K = s(0.167 - 0.005s) - \frac{0.061(v-800)}{800}, \text{ when } s = 2 \text{ or more.}$$

In developing this section the manufacturers built a testing plant for the purpose of testing and perfecting their product and to get such information as would be needed in designing a hot-

blast system of heating. It was because of the numerous problems that came up while making the first series of tests that prompts the writer to submit this paper. The manufacturers installed a testing plant; the building, having large doors and windows, by the opening or closing of which it was possible to regulate the temperature inside so as to keep it nearly constant during a test, and an attempt was made to have the temperature the same for all the tests. The apparatus in the building consisted of a 110-inch single inlet, top horizontal discharge fan arranged to draw air through a sheet-iron casing in which the sections were arranged as desired for different tests. The fan was driven by a 10-horsepower belted motor at a constant speed of 231 revolutions per minute for all the tests. The outlet of the fan was arranged so that air could be discharged into the building or to the outside, or to both as desired; but during most of the tests that the writer observed the air was discharged into the building.

The outlet of the fan was boarded up until the opening through which the air was discharged was about 21 to 38 inches. It was found that with this size of outlet the velocity of the air passing from the fan was nearly constant at all points of the outlet. For an opening larger than this, it was found that the velocities varied at different points of the outlet to such an extent that it was difficult to determine the actual velocity of the air leaving the fan. The amount of air that the fan handled per minute was varied by reducing the size of the outlet. The velocity of the air was not quite constant at the outlet of the fan for smaller areas of the outlet, but it was nearly so. The velocity was also affected somewhat by the number of sections in depth of the heater being tested. The volume of air passing through the heater was determined by multiplying the area of the outlet in square feet by the velocity in feet per minute of the air passing through the outlet, as determined by means of an anemometer. The readings of the anemometer gave concordant results. The temperature of the air as it left the outlet was taken, and this volume reduced to an "equivalent volume at 70 degrees"—that is to say, air at 70 degrees was taken as the standard, and all tests were made upon this basis.

The velocity of the air passing through the heater was obtained by dividing the volume of air passing per minute, when reduced to 70 degrees, by the free area of the heater; and in the following tests the free area of the heater was, in all cases, 9.21 square feet.

The heater was arranged in six groups, each group being ten sections wide and one section deep, and containing 170 square feet of heater surface. The sheet-iron casing for the heaters was arranged so that as many groups as desired could be used, and tests were made with from one to six groups in use. Groups not in use were removed from the casing, so as to leave only those groups actually in use in the casing. Steam was supplied through a 3-inch main leading from an adjoining building through a Kieley special reducing pressure valve to a 5-inch main, to which each of the groups of the heater was connected by the flanged nipple. A thermometer was calibrated and placed in the low pressure main, and readings taken from it gave the temperature of the steam in the water. Steam was supplied to the top of each group, and the water of condensation was drawn off from the bottom at the opposite end of the group.

The air drawn through the heaters was in all cases taken from outside of the building through a door which was of the same size as the casing of the heater. The bottom of this door was about seven feet from the ground, and the outside or initial temperature of the air was measured about four and one-half feet above the ground directly below this door.

According to the report of these tests, one of the first problems that the experimenters had to deal with, was the determination of where the final temperature should be measured. The first group of sections was placed about four and one-half feet from the inlet of the fan, and an attempt was made to measure the temperature of the air in this space between the fan inlet and the first group of sections. A thermometer was hung in this space and its temperature noted. This thermometer indicated a very high temperature. Then a screen was placed between the group of heater sections and the thermometer so as to reduce the effect of direct radiation from the first group. Various sizes and forms of screen were used, but it was found impossible to avoid to some degree the effect of the direct radiation, and hence it was not considered proper to take the reading of a thermometer placed between the fan inlet and the first group of sections as the final temperature of the air. A thermometer was then put just inside the fan casing near the outlet, and readings from it were taken. The readings of this thermometer were usually several degrees lower than the readings of the thermometer between the first group of sections

and the fan inlet. The difference between the readings of the two thermometers was greater when more than one group of sections were in use than when only one group was being used; and it was somewhat more different for low velocities through the heater than it was for high velocities. The report shows that the experimenters finally determined that the reading of the thermometer at the fan outlet should be taken as the final temperature of the air. This means, of course, that the rise of temperature of the air during its passage through the heater was equal to the difference between the temperature as indicated by the thermometer at the outlet of the fan and that indicated by the thermometer hung outside of the building.

It is a question that I bring before this Society for discussion, as to whether the temperature indicated by the thermometer between the fan inlet and the first group of sections should not have been taken as the final temperature of the air? It is evident, of course, that during the passage of the air through the fan there was some loss of heat and some cooling of the air. How much this amounted to it is impossible to say. Attention was directed principally to determine the rise of temperature of the air for various velocities through the heater. It is evident that this course was pursued because if the rise of temperature of the air while passing through the heater is taken as the measure of the efficiency for heating power of the heater, it would enable the makers of the sections to sell them on a guarantee, the fulfillment of which could be easily determined by hanging two thermometers in such position as to indicate the initial and final temperature of the air passing through the heater.

The next problem was to determine the volume of air passing through the heater per minute. Here considerable difficulty was encountered, and it was finally decided that, as stated before in this paper, the velocity of the outlet should be determined by means of a anemometer. Several readings were taken at the outlet during each test, and the average of these readings was taken as the velocity of the air passing through the outlet during the test. Three different sized outlets were used as a rule, although in some subsidiary tests a fourth size was used. It was found that for a given size of outlet the velocity was nearly constant for any number of groups of sections in the heater. The largest outlet used was 21 by 38 inches, the next size was 18 by 38, the next

15 by 38, and the next 12 by 38 inches. The smallest opening was not used very much.

In measuring the velocity of the air passing through the outlet one anemometer was checked against another anemometer for accuracy. An attempt was made to determine the velocity by means of a Pitot tube, such as shown in Fig. 3. The Pitot tube is shown in the upper left-hand corner of this figure, and an apparatus for indicating the static pressure is shown in the upper

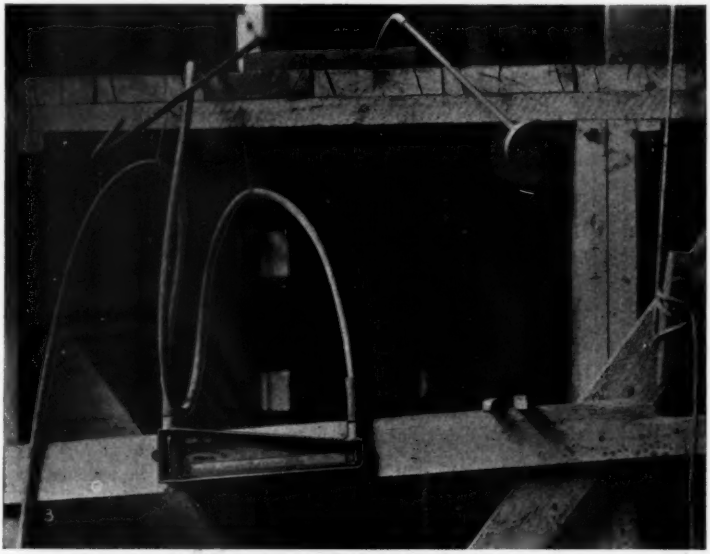


FIG. 3.

right-hand corner of the figure. This apparatus consisted of two metal disks, each about three inches in diameter, having between them a third disk, about six inches in diameter, made of ordinary wire screening such as is used for windows. To the center of one of the metal disks was screwed a rod, and from this rod a rubber tube led to a leg of a draft gage. The other leg of the draft gage was connected to the Pitot tube. The result of this arrangement was that the reading of the draft gage showed at once the pressure or head producing the velocity of the flow of air at the outlet. The head fluctuated so widely for slight changes

in position of the tube in the outlet that the results of these readings could not be used with any degree of satisfaction.

Fig. 4 shows the reducing pressure valve and the thermometer in the steam pipe. The reading of this thermometer was taken as the temperature of steam in the pipe. Gages were used simply as checks. During the entire series of tests, when the

FIG. 4.

reducing pressure valve was once set, it was seldom that the temperature varied more than one degree.

Another problem that required solution was how to determine the frictional resistance to the flow of air through the heater at different velocities. This required some means for determining the loss in pressure due to the resistance of the heaters as the air passed from the outside through them to the fan. This was finally determined by means of a static pressure gatherer attached

to a tube that was in turn attached to a draft gage. This gatherer was similar to the one used in connection with the Pitot tube, was arranged so that it magnified ten times—in other words, a difference of reading of one inch meant a difference in pressure of

FIG. 5.

0.1 of an inch. The gatherer itself was placed between the fan and the first group of sections, as shown in Fig. 5.

The results of the tests were very uniform for similar conditions. After the apparatus had been started and run until normal conditions had been reached, it was found that from this time on, as long as the conditions remained the same, there was practically

no change in the working of the apparatus. A rise of one degree in the outside temperature was followed at once by a rise of one degree in the final temperature of the air. The motor maintained a uniform speed, and hence the fan discharged a uniform volume of air through the outlet; this meant a uniform velocity of the air through the groups being tested, and was checked by the draft gage, which showed that the frictional resistance of the heaters was constant.

It is evident that if the frictional resistance is constant for a given velocity of air through a heater composed of a given number of sections in depth, and if we can determine what this resistance is, we have at once a means by which we may determine how much air is passing through a given heater. This is found by determining the resistance to the passage of the air, expressed in inches of water, and then turning to a table prepared from a standard heater giving the velocity of the air through a heater of the same number of sections in depth, read off the volume of air passing per minute.

If the scheme suggested in the report of these tests be carried out to this extent, it is evident that when such cast-iron sections are installed in a plant under a guarantee to raise the temperature of the air through a given number of degrees that it becomes a very easy matter for anyone to make a test of the plant. All that would be necessary would be to put in a draft apparatus and obtain the velocity of the air passing through the heater, and then to put in two thermometers by which the initial and final temperatures of the air would be determined. Knowing the velocity of the air through the heater, and knowing the free area of the heater, the product would be the volume of air passing through the heater per minute. So that from readings of two thermometers, and the reading of a single draft gage, we will be able to determine how many cubic feet of air was being handled per minute and through what rise of temperature this air was being heated. This, in my mind, would present a great advantage in favor of the use of these heater sections, in addition to the other advantages which they may have. And this great advantage is due to the fact that the heating effect of the sections is uniform and the resistance to the flow of air through a heater made of these sections is also uniform for a given velocity.

Table 1 gives the rise of temperature per degree difference be-

tween the temperature of the steam and the mean temperature of the air for different velocities of air. (See p. 109.)

Table 2 gives the heat units transmitted per square foot of heating surface per hour per degree difference between the temperature of the steam and the mean temperature of the air.

TABLE 2.

HEAT UNITS TRANSMITTED PER SQUARE FOOT OF HEATING SURFACE PER HOUR PER DEGREE DIFFERENCE BETWEEN THE TEMPERATURE OF THE STEAM AND THE MEAN TEMPERATURE OF THE AIR.

Velocity, feet per minute.	Number of sections heater is deep.					
	1	2	3	4	5	6
1600	11.94	12.17	12.67	12.67	12.50	12.20
1500	11.91	11.76	12.11	12.06	11.86	11.56
1400	11.70	11.28	11.50	11.41	11.18	10.89
1300	11.50	10.79	10.89	10.75	10.51	10.22
1200	11.11	10.21	10.22	10.05	9.81	9.52
1100	10.72	9.63	9.55	9.34	9.09	8.82
1000	10.23	8.99	8.84	8.61	8.36	8.10
900	9.59	8.28	8.08	7.85	7.60	7.35
800	8.90	7.56	7.31	7.08	6.48	6.60

Table 3 shows the final temperature of air entering in the heater at a temperature of zero degree when the temperature of the steam in the heater is 227 degrees, corresponding to a pressure of steam of five pounds by the gage.

TABLE 3.

FINAL TEMPERATURE, T, OF AIR WHEN ENTERING HEATER AT 0 DEGREE. TEMPERATURE OF STEAM IN HEATER, 227 DEGREES. VOLUME OF AIR MEASURED AT 70 DEGREES.

Velocity, feet per minute.	Number of sections heater is deep.					
	1	2	3	4	5	6
1600	26.5	51.0	74.9	94.7	111.3	125.2
1500	28.1	52.4	76.3	95.8	112.4	126.0
1400	29.5	53.8	77.2	76.7	113.3	126.8
1300	31.1	55.0	77.6	97.9	114.3	127.7
1200	32.4	56.4	79.6	99.0	115.3	128.7
1100	34.0	57.7	80.5	100.0	116.2	129.6
1000	35.6	59.1	82.0	100.1	117.2	130.5
900	36.9	60.1	83.0	102.1	118.0	131.3
800	38.5	61.6	84.3	103.1	119.0	132.3

t = final temperature of the air which enters at 0 degree.
k = rise per degree difference between the temperature of the steam and the mean temperature of the air.

$$t = \frac{454\,k}{2 + k}$$

Table 4 shows the friction loss, or resistance to the flow of air

through a heater made of these sections, for different velocities of air in feet per minute.

TABLE 4.

FRICTION LOSS IN INCHES OF WATER DUE TO THE SECTIONS. VOLUME OF AIR MEASURED AT 70 DEGREES.

Velocity, feet per minute.	Number of sections heater is deep.					
	1	2	3	4	5	6
1600	0.236	0.288	0.416	0.543	0.672	0.800
1500	0.207	0.253	0.366	0.477	0.590	0.703
1400	0.180	0.220	0.318	0.415	0.514	0.613
1300	0.156	0.190	0.274	0.358	0.443	0.528
1200	0.133	0.162	0.234	0.306	0.378	0.450
1100	0.111	0.136	0.197	0.257	0.318	0.378
1000	0.092	0.112	0.162	0.212	0.262	0.312
900	0.074	0.091	0.132	0.172	0.212	0.253
800	0.059	0.072	0.104	0.136	0.167	0.200

f = friction loss in inches of water.
v = velocity in feet per minute.
s = number of sections heater is deep.

$f = 1.47\left(\frac{v}{4{,}000}\right)^2$, where $s = 1$.

$f = (0.8s + 0.2)\left(\frac{v}{4{,}000}\right)^2$, where $s = 2$ or more.

In all of these tables the volume of the air is measured at 70 degrees, and the velocity of the air passing through the heater is obtained by dividing the volume measured at 70 degrees by the free area of the heater.

It is to be hoped that this short statement of some of the problems encountered in making tests on the cast-iron heaters to which I have referred in this paper will be of value to others, and will bring from those who have already made tests some expression of opinion or some statement as to how they have met and solved these same problems. The results which have been given in the tables are not so much in themselves as they point to the results that ought to be obtained under good conditions.

If this paper will bring out a full discussion of the problems encountered in the use of cast-iron heaters, it will have served its purpose, and the author will feel that his efforts have not been in vain.

In conclusion, I take pleasure to thank Prof. J. H. Kinealy for considerable data gathered during the tests; also Professor Kent for a number of suggestions while the tests were being made.

I did not attempt to plot results. I leave it to investigators to check the results and plot curves from formulæ given at the bottom of each table.

DISCUSSION.

Mr. Davis: I would like Mr. Weinshank to go to the board and show us where the prominent points are on which he asks the opinion of the Society.

Mr. Weinshank: Since the inside and outside temperature varied, we reduced this volume to an equivalent volume at 70 degrees. That is to say, air at 70 degrees was taken as the standard and all tests were made upon this basis.

In reference to rise of temperature, as shown in Table No. 3, I will state that a thermometer was suspended in the casing between the heater and the fan at B (Fig. 1). The temperature recorded at this point was greater than we expected.

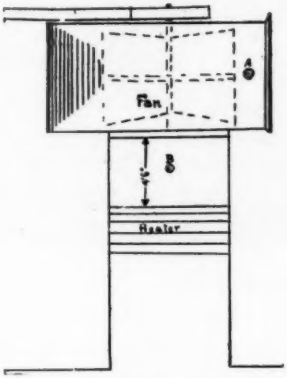
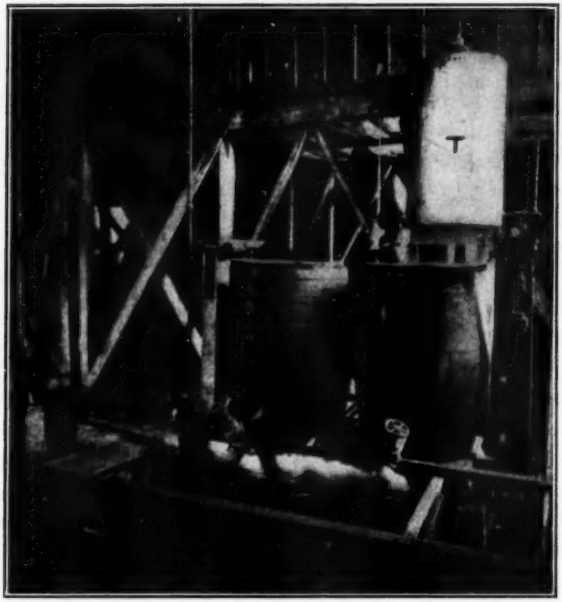


FIG. 1.

We interpreted this high temperature being due to the radiation and velocity of the air. To overcome this another thermometer was suspended at *A* (Fig. 1) and the difference noted. The readings at *A* were considerably lower than at *B*, which was probably due to losses by radiation from the fan or for some other reasons. In order to have this loss constant during the tests, we endeavored to retain a constant temperature in the room in which the tests were made.

To determine or not whether the air is passing over the heater uniformly, and whether or not the air is being heated uniformly over the entire surface of the heater, the thermometer at *B* was

placed at different levels between the heater and the fan, and no variation of temperature could be detected. This led us to be-



MR. WEINSHANK'S SKETCH, FIG. 2.

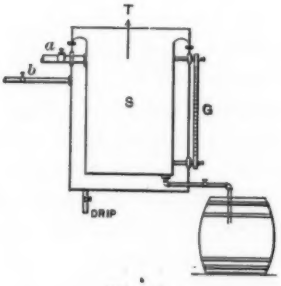


FIG. 3.

lieve that the distribution of the air throughout the entire surface was uniform.

President Mackay: Have you any tests showing the condensation?

Mr. Weinshank: In this paper the writer intended to bring forth the efficiency of the heater from a standpoint of a temperature-rise, and, therefore, the question of condensation has been omitted, but for your information I will state that the method of recording the amount of condensation was conducted as follows:

Fig. 2 shows the general arrangement of the tank and weighing barrels. Fig. 3 shows a section through the tank. This apparatus consists of two tanks *T* and *S*. Tank *S* was suspended inside of the tank *T*, riveted solid to the outer wall of tank *T*. The condensation from the heaters was connected to the inner tank *S* by means of pipe *a* properly valved. The tank *S* was also supplied with a calibrated glass gauge *g*. This gauge was calibrated so that an inch of water in the tank meant so many pounds. In order to retain the temperature of the water of condensation, the outer tank *T* was provided with a pipe *b*, properly valved and supplied with live steam from the boilers.

Thus the water of condensation was of the same temperature as the steam. If the tank *S* filled up to a certain height, the valve *a* was closed and *c* opened and discharged into the barrel. As soon as the water was discharged *c* was closed and *a* opened again. The intention was to calculate the heat units transmitted per square foot of heating surface per hour per degree difference, as per Table II., taking into consideration the latent heat only.

President Mackay: How do you find the comparison of the cast-iron heater as against steam-pipe coils?

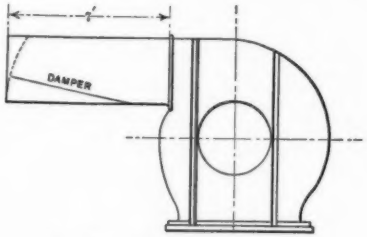
Mr. Weinshank: Table I. shows that there is very little difference as far as rise of temperature is concerned between the cast-iron heater and that of pipe coils. The only difference we found is that whereas in ordinary pipe blast coils it was impossible to get a uniform temperature in the space between the coils and the fan, we have been able to secure a uniform flow as well as a uniform temperature in the entire space between the fan and coils. The reasons for this difference we have ascribed to the construction of the heater, etc.

Mr. Braemer: I have always found that even if the distance between fan inlet and coils is large enough to place the thermometer outside of the influence of the direct radiation from the coils, a thermometer placed between fan inlet and heater

XUM

coils indicates the temperature varying greatly in the different strata of air, the lower strata naturally being cooler, and in order to obtain the temperature fairly accurate the average of a series of readings in the different strata must be taken. Whenever possible I always place the thermometer in the air duct close to fan outlet, as the air after passing through fan is well mixed and of a fairly uniform temperature. As Mr. Weinshank states, there undoubtedly is a very small drop in air temperature in passing through the fan, due to loss through radiation, but this loss is so small in most cases that for practical purposes it may be neglected.

Mr. Weinshank states that, in order to determine the air volume handled, the outlet of the fan was boarded up until the



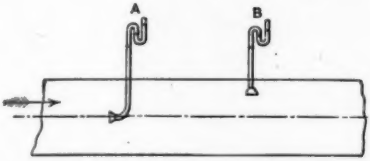
MR. BRAEMER'S SKETCH, FIG. 1.

opening through which the air was discharged was of the size desired, and anemometer readings taken. He also states that for certain sized openings the air velocity was found to vary greatly at different points. It would seem that by "boarding up" the fan outlet in the manner described, corners or pockets would be formed which would produce eddy currents that would make it difficult to obtain fairly accurate readings, either from the anemometer or the draft-gauge. I have frequently, when testing fans on the testing block, used a sheet-iron extension to the fan outlet about 7 feet long, arranged with a damper, as per sketch, Fig. 1.

By this arrangement I am able to obtain at once any desired proportion between the discharge opening and the fan outlet, at the same time getting a fairly even flow of air through the opening, the velocity at the top being the greatest. In order to obtain the velocity accurately I have always found it necessary to

divide the discharge opening into six or more squares by means of wires strung lengthwise and crosswise in front, and taking the average of a series of readings from each square. As a general rule, I have found the air velocity too high for application of an anemometer and have used a Pitot tube connected to a " U " tube draft gauge.

Referring to sketch, Fig. 2, and assuming the flow in the air



MR. BRAEMER'S SKETCH, FIG. 2.

duct in the direction of the arrow, the reading of the draft gauge if the Pitot tube is held in position " A " will indicate the total pressure; the draft gauge if the tube is arranged in position " B " will indicate the static pressure, and the difference between the two readings will indicate the pressure corresponding to the air velocity, which will enable us to calculate the volume of air passing.

CXCIII.

COEFFICIENTS OF TRANSMISSION IN CAST-IRON RADIATORS.

BY JOHN R. ALLEN.
(Member of the Society.)

The results given in this paper are from tests made to determine the variation of the coefficient of conduction with different temperatures of steam and air on the two sides of a cast-iron radiator. These tests were conducted in the laboratory of the engineering department of the University of Michigan.

METHOD OF MAKING TEST.

The tests were conducted in the usual manner in the radiator testing plant at the University of Michigan under a wide range of conditions. The steam pressure was varied from seventy pounds gage pressure per square inch to atmospheric pressure, and the room temperature from 117 to 51 degrees F. The number of tests made was thirty-six. During all the tests the humidity of the atmosphere was noted. As will be noticed in Table I, the moisture was extreme in certain cases. These excessively high percentages of moisture were obtained by introducing steam into the air of the room.

In every test two radiators were tested. One which is permanently located in the testing plant, termed the Standard radiator; the second, which may be changed from time to time, is termed the test radiator. During these tests the standard radiator was a cast-iron radiator of the two-column type, and the test radiator a cast-iron radiator of the three-column type. These radiators are similarly situated in the room. Most of these tests were made at night to avoid the effects of the sun.

RESULTS OF THE TESTS.

The results of the tests are shown in Table I.

TABLE I.

No. of Test.	Outside Temperature.	Relative Humidity.	Barometer.	Gauge Pressure.	Absolute Pressure.	Temperature of Steam.	Average Room Temperature.	Temperature Difference.	B.T.U.'s per lb. of Steam Condensed.	Condensation Std. Radiator.	Condensation Test Radiator.	B.T.U.'s per sq. ft. per hour Std. Radiator.	B.T.U.'s per sq. ft. per hour Test Radiator.	B.T.U.'s per sq. ft. per degree per hour Std. Radiator.	B.T.U.'s per sq. ft. per degree per hour Test Radiator.	Quality of Steam.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	4.0	47.	29.13	50.1	64.7	297.5	51.2	246.3	896.0	28.74	23.80	554.0	585.0	2.245	2.375	99.
2	21.	59.	29.22	68.3	82.66	339.	82.9	231.0	885.0	27.07	21.41	515.0	532.0	2.230	2.304	99.
3	14.9	84.	29.41	66.7	81.16	312.8	56.9	256.9	885.5	30.04	23.47	572.0	670.0	2.218	2.221	99.
4	15.0	91.	29.44	70.	84.46	315.6	59.6	256.0	884.	30.29	24.56	576.5	595.0	2.262	2.323	99.
5	38.	95.	28.69	65.	79.08	311.	78.3	232.7	885.5	25.00	19.66	476.0	477.4	2.048	2.050	98.9
6	26.4	94.4	29.24	69.4	83.76	315.	81.1	233.9	883.	24.30	19.65	462.0	476.0	1.978	2.037	88.9
7	33.9	57.	28.96	69.8	84.0	315.2	98.	217.2	881.4	24.40	19.60	463.0	473.5	2.130	2.177	98.7
8	33.3	53.	29.43	64.9	79.35	311.2	97.3	213.9	885.6	23.56	18.89	449.0	458.0	2.100	2.140	98.8
9	29.3	58.	29.43	55.3	69.75	302.5	93.2	209.3	890.7	23.20	16.78	449.0	458.0	2.120	2.187	98.8
10	26.1	43.	28.87	54.7	68.88	301.6	106.1	195.8	894.6	20.82	16.74	400.0	410.0	2.045	2.098	99.2
11	43.5	45.5	28.83	45.3	52.45	291.9	103.	188.9	900.6	20.21	15.98	388.0	394.2	2.055	2.088	99.1
12	31.8	54.	29.30	36.4	59.79	281.8	85.7	196.1	907.9	20.05	16.25	392.3	404.5	2.000	2.060	99.0
13	40.8	47.	29.49	30.6	45.1	274.4	91.6	182.9	915.6	18.16	14.66	367.5	368.0	1.955	2.015	99.4
14	40.6	53.	29.50	25.5	40.0	267.1	90.7	176.4	919.6	17.78	14.43	350.0	364.0	1.988	2.062	99.8
15	42.9	49.	28.97	21.0	35.2	252.5	92.4	157.1	924.9	15.96	12.28	317.2	311.4	1.898	1.864	99.5
16	35.1	49.	28.97	30.9	46.1	274.4	95.0	179.4	914.5	17.92	14.06	352.0	352.0	1.962	1.965	99.3
17	51.5	56.	28.81	10.5	24.63	239.2	93.2	146.0	940.0	13.50	10.58	273.0	272.0	1.076	1.862	99.3
18	65.8	45.	29.05	10.8	25.06	240.1	102.9	157.2	939.4	12.04	9.59	243.0	247.0	1.770	1.800	92.3
19	64.5	45.	29.40	20.4	34.66	250.6	107.2	151.4	925.8	14.35	11.44	285.7	291.5	1.886	1.926	99.4
20	41.5	45.	29.25	10.6	24.95	239.9	90.7	149.2	936.0	13.54	10.47	273.0	268.8	1.830	1.802	99.
21	39.0	38.	29.14	10.6	24.90	239.8	95.6	144.2	936.0	13.04	10.22	262.0	262.2	1.818	1.820	99.
22	33.0	72.	28.65	19.9	33.97	252.4	90.7	165.5	919.7	15.25	12.52	301.8	316.0	1.811	1.900	98.5
23	40.7	72.	28.89	19.8	34.0	257.5	90.8	161.7	921.2	15.06	11.72	298.1	296.7	1.844	1.833	98.8
24	35.2	65.	29.00	68.3	82.55	314.	109.7	204.3	876.1	22.45	17.61	423.0	424.0	2.070	2.073	98.1
25	43.0	64.	28.99	40.8	55.02	286.9	105.8	181.1	895.1	20.30	14.80	389.0	362.5	2.144	2.004	98.1
26	36.3	76.	28.18	49.8	63.9	296.6	89.4	207.2	889.7	22.15	17.10	423.5	416.8	2.040	2.010	98.1
27	37.2	43.	29.15	20.	16.32	217.3	91.0	126.3	860.0	10.58	8.38	219.0	221.0	1.734	1.750	99.
28	49.3	87.	29.16	62.	19.52	226.6	101.3	124.8	846.0	10.60	8.46	215.8	218.9	1.729	1.756	99.
29	41.0	95.	29.20	94.	23.85	237.2	117.2	120.0	940.2	10.11	7.90	204.3	203.9	1.702	1.699	99.3
30	62.8	44.	29.06	14.5	28.77	247.9	104.1	143.8	931.0	13.30	10.29	266.1	262.8	1.850	1.826	98.5
31	58.6	68.	29.33	2.6	17.	221.5	104.4	117.1	960.6	9.58	7.09	197.8	186.7	1.688	1.592	99.
32	44.5	54.	29.30	1.63	16.03	217.4	101.0	116.4	963.7	10.02	7.47	207.0	197.1	1.786	1.693	99.
33	57.9	51.	29.18	1.48	15.79	219.6	105.2	144.	965.2	9.44	7.21	195.8	190.8	1.710	1.669	99.
34	64.8	39.	29.16	.74	15.05	214.5	103.8	110.7	955.0	9.14	6.93	189.6	184.6	1.710	1.669	99.
35	73.1	40.	29.05	.70	14.98	212.7	105.0	107.7	565.2	8.97	6.49	196.0	171.6	1.730	1.592	99.
36	38.6	41.	29.17	.86	15.17	214.8	94.1	120.9	964.8	10.18	7.75	210.5	202.0	1.746	1.677	99.

The particular object of the tests was to obtain the coefficient of transmission, as shown in columns 15 and 16. The coefficient of transmission is obtained by dividing the B. T. U.'s transmitted per square foot of radiation per hour by the difference between the steam and room temperature. In the curve shown in Fig. 1 the coefficient of transmission for the two-column radiator has been plotted as abscissae, and the difference between steam and room temperature as ordinates.

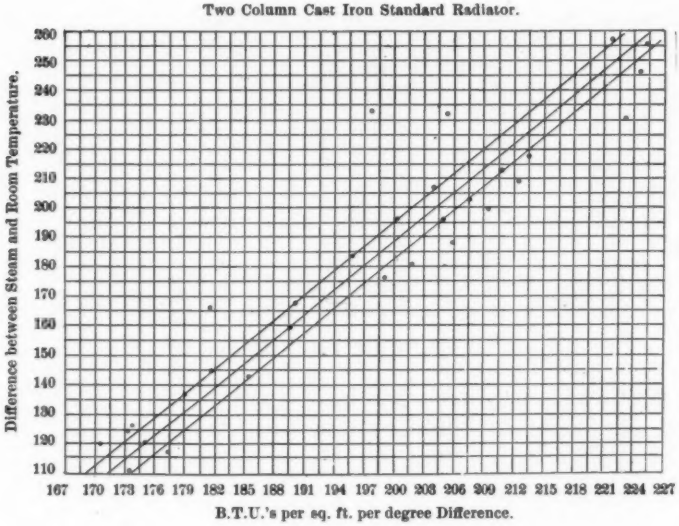

Two Column Cast Iron Standard Radiator.
Difference between Steam and Room Temperature.
260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110
167 170 173 176 179 182 185 188 191 194 197 200 203 206 209 212 215 218 221 224 227
B.T.U.'s per sq. ft. per degree Difference.

FIG. 1.

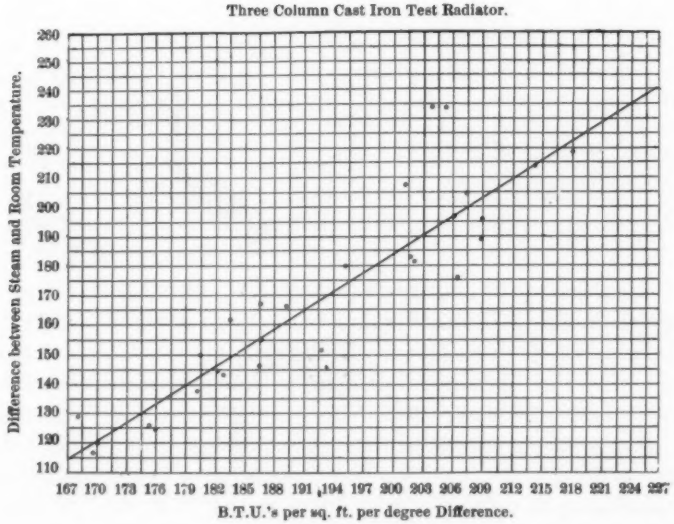

Three Column Cast Iron Test Radiator.
Difference between Steam and Room Temperature.
260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110
167 170 173 176 179 182 185 188 191 194 197 200 203 206 209 212 215 218 221 224 227
B.T.U.'s per sq. ft. per degree Difference.

FIG. 2.

In Fig. 2 the coefficient of transmission for the three-column radiator has been plotted in the same way as in Fig. 1. From the curves in Figs. 1 and 2, Table II has been obtained. From Fig. 1 we get the equation representing the variation of the coefficient of transmission with the change in difference between steam and room temperature.

TABLE II.

COEFFICIENT OF HEAT TRANSMISSION.

Difference in temperature between steam and room.	B.T.U.'s per square foot per hour per degree difference of temperature.	
	2 column radiator.	3 column radiator.
110	1.71	1.65
120	1.745	1.695
130	1.76	1.745
140	1.82	1.79
150	1.855	1.835
160	1.895	1.885
170	1.93	1.93
180	1.965	1.98
190	2.00	2.025
200	2.04	2.075
210	2.075	2.12
220	2.11	2.165
230	2.15	2.215
240	2.185	2.260
250	2.22	2.31
260	2.265	2.36

If we let

c = coefficient of transmission,
t_3 = temperature steam in the radiator,
t_2 = temperature of the room,

then from the results obtained

$C = .0036\ (t_3 - t_2) + 1.32$ for a 2-column cast-iron radiator,
$C = .00467\ (t_3 - t_2) + 1.14$ for a 3-column cast-iron radiator.

The most interesting application of this equation is in determining the temperature of a room for various conditions of the outside temperature. The case often arises where a contractor guarantees to heat a building to 70 degrees with a temperature outside at 0 degree. When the heating plant is finished what temperature should the room be heated with a higher temperature than 0 degree outside in order that the building may be heated to 70 degrees with 0 degree outside? This equation permits of a more accurate solution of this problem. The following demonstration gives a solution of this problem:

Assume t_1 = temperature of the outside air for contract condition.

Assume t_2 = temperature of air in the room which was guaranteed by contractor.

Assume t_3 = temperature of steam in the radiator during test.

Assume t_4 = actual temperature of outside air during test.

Assume t_5 = computed temperature of room for test conditions.

Heat loss from room under contract conditions.

$$= \left(\frac{W}{4}+G\right)n(t_2-t_1) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Heat loss from radiator under contract conditions.

$$= (t_3-t_2)[.0036(t_3-t_2)+1.32] \quad . \quad . \quad . \quad . \quad (2)$$

Heat loss from room under test conditions.

$$\left(\frac{W}{4}+G\right)n(t_5-t_4) \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Heat loss from radiator under test conditions.

$$(t_3-t_5)[.0036(t_3-t_5)+1.32] \quad . \quad . \quad . \quad . \quad (4)$$

Equation (1) must equal equation (2), equating and dividing by $t_2 - t_1$.

$$\left(\frac{W}{4}+G\right)n=\frac{(t_3-t_2)[.0036(t_3-t_2)+1.32]}{t_2-t_1} \quad . \quad . \quad . \quad (5)$$

and equation (3) must equal equation (4), equating and dividing by $t_5 - t_4$.

$$\left(\frac{W}{4}+G\right)n=\frac{(t_3-t_5)[.0036(t_3-t_5)+1.32]}{t_5-t_4} \quad . \quad . \quad . \quad (6)$$

Equating the right-hand member of these equations we have

$$\frac{(t_3-t_2)[.0036(t_3-t_2)+1.32]}{t_2-t_1} = \frac{(t_3-t_5)[.0036(t_3-t_5)+1.32]}{t_5-t_4} \quad . \quad (7)$$

The unknown quantity in this equation is t_5, and this is involved as a quadratic, so that the general solution of the equation is a

long one. It is customary to assume, however, that the outside air t_1 — 0 degrees, the room temperature t_2 — 70 degrees, and steam pressure in the radiator is five pounds per square inch, then t_3 — 227. Substituting these values in equation (7) we have

$$4.15=\frac{(227-t_5)[.0036(227-t_5)+1.32]}{t_5-t_4} \quad . \quad . \quad . \quad (8)$$

$$4.15(t_5-t_4)=.0036(227-t_5)^2+1.32(227-t_5) \quad . \quad . \quad (9)$$

Solving this equation as a quadratic for t_5 in terms of t_4 we get

$$t_5=987-\sqrt{840{,}000-1{,}153t_4} \quad . \quad . \quad . \quad . \quad (10)$$

for a two-column cast-iron radiator.

For the three-column cast-iron radiator this equation becomes

$$t_5=793-\sqrt{523{,}000-887t_4} \quad . \quad . \quad . \quad . \quad (11)$$

As an example, suppose a heating contractor guarantees to heat a house to 70 degrees in zero weather with two-column cast-iron radiation. When the house is finished the lowest temperature obtainable is 40 degrees. What should be the temperature in the house with 40 degrees outside in order to fulfill the original guarantee? Substituting 40 degrees for t_4 in the above equation, we find as the result that the temperature of the house should be 97 degrees.

Table III shows the temperature that should be obtained in a room for various outside temperatures, the original guarantee being to heat the house to 70 degrees in zero weather. The table is computed by substituting in equation (10) Table III has been

TABLE III.

[Room Temperature Corresponding to Temperature of Outside Air.

Temperature of outside air.	Temperature of room 2 column radiator.	Temperature of room 3 column radiator.
-30	52	53
-20	58	59
-10	64	64
0	70	70
10	77.5	75
20	83	83
30	90	89
40	97	95
50	103.5	105.5
60	110	108
70	117	115
80	123.5	121.5
90	130	128
100	137	134.5

plotted in the form of a curve shown in Fig. 3, and from this table intermediate points can be obtained.

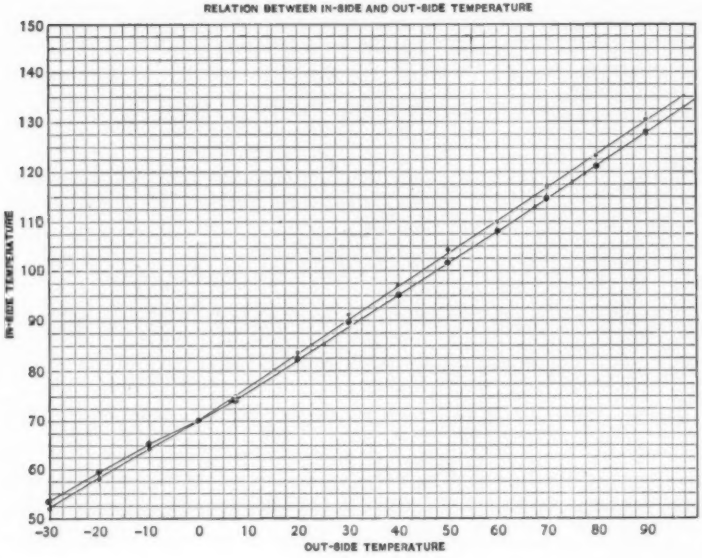


FIG. 3.

APPROXIMATE EQUATION.

If we ignore the difference in the change of the coefficient of transmission and assume it a constant, then equation (7) reduces to

$$\frac{t_3-t^2}{t_2-t}=\frac{t_5-t_4}{t_3-t_5} \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Making the same assumption as in equation (8), equation (12) becomes

$$t_5=.693t_4+70.$$

In using this approximate expression the error is about 2 per cent. at 40 degrees and about 10 per cent. at 100 degrees outside temperature. This shows that in most cases where this computation is made the use of the more exact expression is not necessary.

THE EFFECT OF MOISTURE IN THE ATMOSPHERE.

Fig. 4 shows the effect of moisture in the atmosphere upon the transmission of heat through the radiator. This curve is

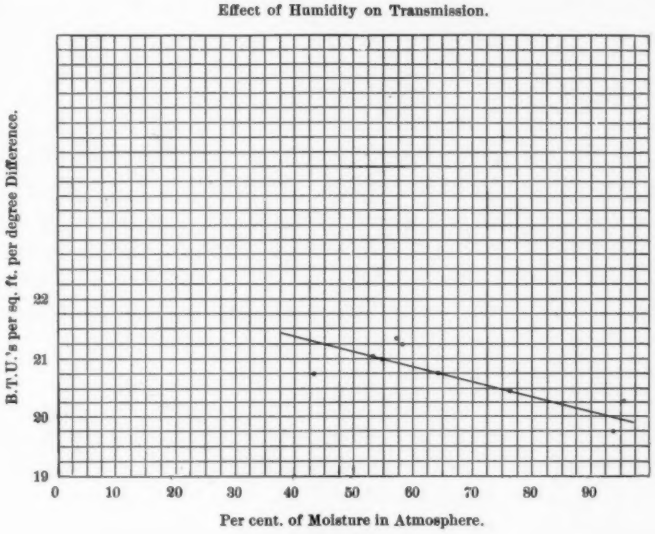


FIG. 4.

plotted for difference of temperature between steam and air varying from 244 to 200 degrees. The per cent. of moisture in the air is plotted as abscissae and the B. T. U.'s transmitted as the ordinates. The curve indicates that the rate of transmission of heat diminished as the per cent. of moisture in the atmosphere increases. The extreme range of moisture ordinarily met with in any locality varies from 40 to 90 per cent. of saturation. This extreme variation in moisture produces a change in the coefficient of transmission of approximately 5 per cent.

EFFECT OF WINDOW SURFACE.

The earlier radiator tests conducted at the University of Michigan were made in a room having a small amount of glass surface. Two years ago a new radiator testing plant was built. In this plant the room in which the radiators are tested contains about 40 per cent. glass surface.

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The difference in the results obtained were at once very marked. Under the new conditions the coefficient of heat transmission in the test radiator was increased from 1.68 to 1.86, or an increase of 10.7 per cent. This would account in a large measure for the different results obtained by different experimenters on the same form of radiator.

DISCUSSION.

Mr. Donnelly: In connection with the topic for discussion and the report of these radiator tests, in my opinion it is quite probable that the heating engineer is doing more work and experimenting much more on the mechanical mixture of air and steam than any other professional man. I want to make a statement that I think he knows less about what he is handling than he should; in the hope that it will stir up some one to contradict it and give us some information.

It is quite probable that all the radiator tests which have been made are more or less unreliable, for the assumption has always been made that the radiators have been filled with steam, and no tests have been made, so far as I have heard, to ascertain correctly and exactly what really is inside the radiator.

In some descriptions that have been published as to standard methods of making radiator tests, directions have been given to open the outlet and let it blow thoroughly, in order to be sure that all the air is removed, as, if any is left in the radiator, it will seriously affect the result.

It is probably under these conditions that the air removal is better than under average operating conditions, where the return or air valve is not allowed to blow thoroughly.

Again, under operating conditions, in order to get perfect air removal, all the air would have to flow out of the steam and return mains as well as out of the radiators, and though a good air removal might be obtained from the radiators, air might collect in them or mix with the steam so that there would be a varying and unknown quantity of air present.

The radiator tests, as given, show quite a variation in the factor of transmission per square foot, per degree, where varying pressures of steam are used.

This result is supposed to be caused, primarily, by the use of

higher pressures and temperatures, and there is a possibility that almost all of it, and certainly some of it, is caused by the quantity of air left in the radiator.

For instance, if a radiator is started up with steam, at about atmospheric pressure, and the return blown thoroughly, so that 90 per cent. of the air is driven out; if the pressure of the steam is then raised to 15 pounds gauge, the air would be compressed into about one-half its former volume, would probably form a better mechanical mixture with the steam, and you would have 95 per cent. air removal. If the absolute pressure inside the radiator was again doubled, we would have 97½ per cent. air removal, due to the air being again compressed to one-half its volume.

The opposite effect of this would be produced in systems such as Mr. Hoffman has in mind, and I think it would be the cause of the trouble which he mentions, and to which this topic for discussion is directed. If there is 90 per cent. air removal with steam at atmospheric pressure, and the steam is then allowed to drop to 20 inches of vacuum, the air would expand as well as the steam in the radiator to about three times its former volume, and we would then have only a 70 per cent. air removal. Added to this effect I think the air would disassociate itself from the steam, and it would be quite certain that it would collect in one part of the apparatus. The particular point at which it collected might, as Mr. Hoffman states, be one part of the apparatus to-day, and the other end of the house to-morrow.

I still have hopes that some member of the Society will test some radiators and their condensing capacity with a known percentage of air removal, and perhaps also make some tests at the conclusion of the radiator tests to see whether the interior of the radiator has been completely filled with steam during the test, and if it has not, to ascertain how much air has been present.

Mr. G. D. Hoffman: I have in mind a house heated by a low-pressure steam apparatus equipped with vacuum appliances. The system was divided into two circuits. A 2-inch line leading to the back of the house and a 2½-inch leading to the front. While operating under pressure both circuits seemed to work equally free and equally well. This was also true so long as the apparatus was operated under vacuum not exceeding five or six inches.

When the vacuum, however, would begin to register anywhere from ten to fifteen inches, one circuit or the other would begin to cool.

Now the puzzling part to me of this condition was the fact that under apparently the same conditions of outside weather and apparently same conditions inside, one day the front of the house would cool first and another day the back of the house would cool first. The system was apparently equally tight on both circuits, and neither practically nor theoretically have I ever been able to account for the shifting of heat from one end of the house to the other. Theoretically speaking, steam under 20 inches of vacuum has three times the volume of steam under atmosphere, and, looking at it from a purely theoretical standpoint, one would naturally conclude that steam under 20 inches of vacuum ought to fill three times the space, but the actual fact is that it don't. The question is "Why?"

Mr. J. D. Hoffman: I believe one reason that may be assigned, is the reduced pressure of the steam. By reducing the pressure the heat units per cubic foot become less because of the increased volume of the steam. Now, if the main pipes were too small to allow the necessary volume of steam to pass, some part of the system must suffer. The cold side of the house becomes the better condenser, and robs the rest of the house.

Mr. Donnelly: Taking up what Mr. Hoffman said, I think you will find it incorrect. A year ago last January I read a paper in New York which gave the friction under varying pressures of steam, and when the temperature comes down the friction comes down—and figured it out that these tables of transmission one would nearly balance the other—there wasn't more than 15 per cent. or 20 per cent. difference.

In regard to one side of the house or the other being cool, I believe this is a case of disassociation of steam and air. In a mixture where the air and steam come together they separate when the temperature is brought down. If they do the air must come from the bottom and tend to gather in one pocket, and it is uncertain where it will gather. It might gather one place one day and one place another.

Mr. G. D. Hoffman: The theory being that the air being heavier than steam would create a greater vacuum in the radiator.

Mr. Donnelly: The air would tend to go to the bottom. I think all the air would go to one end of the house and all the steam to the other. When disassociated there would not be a spot of air and a spot of steam, but circulation of steam would tend to bring pockets of air together, and there would be an accumulation until all the air got in one big pocket.

Mr. W. W. Macon: The accompanying tables are designed to cover steam and hot-water radiation. They are designed to al-

TABLE I.

TEMPERATURES FOR TESTING DIRECT STEAM RADIATION PLANTS.

Test condition.	Steam temperature.	Steam pressure intended for zero weather.										
		0	1 lb.	2 lb.	3 lb.	4 lb.	5 lb.	6 lb.	7 lb.	8 lb.	9 lb.	10 lb.
Inches of vacuum. 10 in	192	63.3	62.3	....	....	....	....	....	....	....	....	....
9 in	194.5	64.2	63.2	62.3	....	....	....	....	....	....	....	....
8 in	197	65	64	63	62.2	....	....	....	....	....	....	....
7 in	199	65.6	64.7	63.7	62.8	62	....	....	....	....	....	....
6 in	201	66.3	65.3	64.3	63.4	62.6	62	....	....	....	....	....
5 in	203	67	66	65	64	63.3	62.6	61.9	....	....	....	....
4 in	205	67.6	66.6	65.6	64.7	63.9	63.2	62.5	61.7	....	....	....
3 in	207	68.3	67.2	66.2	65.3	64.5	63.8	63.1	62.3	67.7	....	....
2 in	208.5	68.8	67.7	66.7	65.7	65	64.2	63.6	62.8	62	61.5	....
1 in	210.5	69.4	68.3	67.5	66.4	65.6	64.8	64.2	63.3	62.6	62.1	61.5
Gauge pressure, pounds per sq. in. 0 lb	212	70	68.8	67.8	66.9	66.1	65.3	64.6	63.8	63.1	62.6	62
1 lb	215.5	71.2	70	69	68	67.2	66.3	65.8	65	64.2	63.7	63
2 lb	218.7	72.1	71	70	69.2	68.2	67.3	66.7	65.9	65.1	64.5	64
3 lb	221.7	....	72	71	70	69.2	68.3	67.6	66.7	66	65.4	64.8
4 lb	224.5	....	....	71.8	70.8	70	69.2	68.4	67.5	66.7	66.2	65.7
5 lb	227.2	....	....	....	71.7	70.8	70	69.2	68.3	67.6	67	66 3
6 lb	229.8	....	....	....	....	71.7	70.8	70	69.2	68.4	67.7	67.2
7 lb	232.4	....	....	....	....	....	71.7	70.9	70	69.2	68.6	68
8 lb	234.9	....	....	....	....	....	....	71.7	70.8	70	69.3	68.7
9 lb	237.3	....	....	....	....	....	....	....	71.5	70.5	70	69.3
10 lb	239.4	....	....	....	....	....	....	....	....	71.3	70.7	70
Factors		0.67	0.675	0.678	0.684	0.688	0.692	0.694	0.698	0.702	0.705	0.707

TABLE II.

TEMPERATURES FOR TESTING DIRECT HOT WATER RADIATION PLANTS.

Temperature at test.	Water temperature intended for zero weather.							
	150	160	170	180	190	200	210	220
150	70	65.7	61.8	58.3	....	....	....	....
160	74.7	70	65.9	62.2	59	....	....	....
170	....	74.4	70	66.1	62.7	59.5	....	....
180	....	....	74.2	70	66.3	63	60	....
190	....	....	....	73.8	70	66.5	63.3	60.4
200	....	....	....	....	73.7	70	66.7	63.6
210	....	....	....	....	....	73.5	70	66.8
220	....	....	....	....	....	....	73.3	70
Factors	0.532	0.561	0.588	0.611	0.63	0.648	0.666	0.682

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low the heating contractor to circulate the water at some convenient temperature in the case of hot water, or to operate at some convenient pressure in the case of steam. The indoor temperature that he should realize will be given in the table according to the temperature of water or the pressure of steam at which the system is designed to operate in the severe weather. In other words, if the direct radiation plant is installed to operate in zero weather and maintain 70 degrees indoors when steam is at 3 pounds pressure, instead of running the plant at 3 pounds pressure during the test when it may be, for example, 15 degrees outdoors, the steam plant may be operated at 2 pounds pressure, and the table will show the lowest temperature which the rooms should have if the plant is to be satisfactory at zero weather.

EXAMPLE FOR STEAM HEATING SYSTEM.

For example, suppose that a direct steam radiating plant has been installed under a guarantee to warm the building to 70 degrees when it is zero outside, with the steam at 5 pounds pressure. Rather than waiting until it is zero the contractor makes a test when it is 22 degrees out of doors and circulates steam at 3 pounds pressure. The table is used to determine what the indoor temperature should be if the system can be counted on to meet the specification. It will be noted that each vertical column of Table I. gives figures for the pressure which it is expected to operate during zero weather. The horizontal lines correspond to the pressure at the time of the test. It will be noted in the vertical column marked 5 pounds that opposite the 3 pounds pressure of the test a temperature of 68.3 degrees is to be expected when it is zero outdoors. But the test is made at 22 degrees, not when it is zero. At the bottom of each vertical column is given a factor which is the number of degrees additional which must be realized in the indoor temperature for every degree that the outside temperature is above zero. As the temperature at the time of the test was 22 degrees above zero we must add to 68.3, 22 times 0.692, or 15.2 degrees, making a total of 83.5 degrees, the temperature which should exist indoors.

EXAMPLE FOR HOT-WATER HEATING SYSTEM.

Similarly an example may be worked out for a hot-water system. Suppose that a test is made when it is 10 degrees outdoors of a system designed to operate in zero weather with water at 180 degrees. Suppose the water is at 170 degrees at the time of the test. Opposite 170 in the left-hand column of the table for a hot-water heating system and under the column headed 180 is found the figure 66.1. The factor, or the number of degrees which must be added to the 66.1 for every degree that the outside air is above zero is 0.611. For ten degrees it is 6.1, which, added to 66.1, gives a temperature indoors of 72.2 degrees.

THE BASIS OF THE FIGURES.

These tables are based on the following assumptions: The amount of heat given up by the radiation installed in the building is equal to the number of square feet of radiation multiplied by the number of heat units given off for each square foot of radiation per hour—that is, the heat given off by the entire amount of radiation is equal to $R \times h \times (T - t)$, which means that the total radiation is multiplied by the coefficient of heat transmission per square foot per degree of difference, and this product multiplied by the number of degrees difference between the medium within the radiator and the air outside of it. The amount of heat supplied by the radiators goes toward offsetting the amount of heat lost by the building, including that chargeable to accidental ventilation. This may be expressed as equal to the product of the equivalent glass surface of the exposed walls, the heat given off per square foot of glass per degree difference between indoor and outdoor temperature, and the number of degrees difference—that is, the heat lost by the building, including that lost by ventilation, is equal to $EGS \times u \times (t' - t)$, in which u is equal to the number of heat units lost per hour per square foot of the EGS of the exposed wall for every degree between the temperature indoors and that outdoors. As the heat given off by radiators is equal to that lost through the exposed walls and through leakage ventilation, the two expressions are equal, and it will be seen that

the total amount of radiation multiplied by the coefficient of heat transmission from the radiation is to the product of the EGS and the corresponding coefficient of glass transmission as the difference in temperature indoors and outdoors is to the difference between the temperature of the medium in the radiator and the room temperature. That is

$$\frac{R \times h}{EGS \times u} = \frac{t' - t}{T - t'}$$

As the radiation is in place and is expected to give off the same amount of heat per degree no matter what the temperature in the radiator or in the room is, and as the EGS of the building remains, of course, constant, and the amount of heat transmitted per square foot per hour per degree is also a constant factor, the ratio of heat given up the radiation for 1 degree difference to that transmitted by the wall per degree difference is a constant quantity. This means that the difference in temperature between the indoor and outdoor temperature has always a definite relation to the difference in temperature between the medium in the radiator and the indoor temperature.

If the proper amount of radiation has been installed in a building to operate, say, with steam at atmospheric pressure when it is zero outdoors, maintaining 70 degrees indoors, the ratio of temperature differences is $(70 - 0) \div (212 - 70) = 0.49$. This figure must, according to the assumptions, always give the value of the ratio between the temperature differences stated. In other words, if this same system were tested at 10 degrees outdoors, and with steam at 1 pound pressure—that is, at 215 degrees, the indoor temperature would have to be a definite figure in order that the ratio of the temperature differences should be 0.49. The accompanying tables have been worked up on this basis which should be correct unless outside wall surface will not transmit heat in direct proportion to the difference between indoor and outdoor temperature. It is possible that with the high winds that prevail at outdoor temperatures of 20 degrees, say, almost as much heat is lost through leakage of air through the building walls as when the temperature outdoors is zero and there is little or no wind.

GETTING TEMPERATURE BY MEANS OF DIAGRAM.

As supplementing the tables may be given the accompanying chart suggested recently in *L'Hygiène du Batiment* by Capt. Emile Mathieu, instructor at the Military School of Belgium. This is more comprehensive even than the tables, for it allows

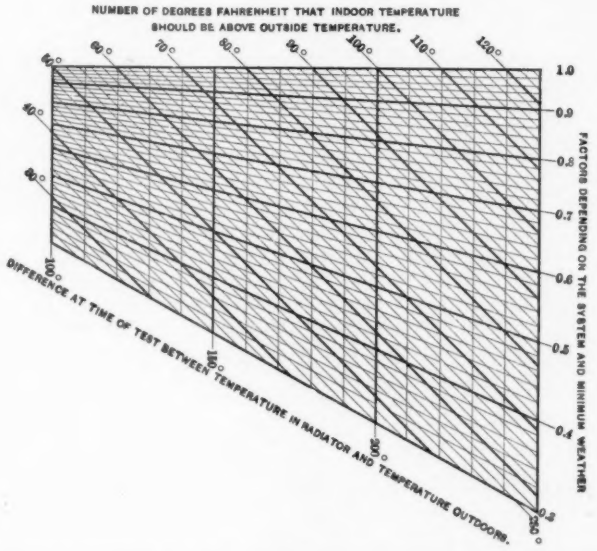


CHART FOR PROVING CAPACITY OF DIRECT RADIATION HEATING SYSTEMS.

Find intersection between diagonal corresponding to the specifications and that giving the temperature difference between radiator interior and outside temperature at time of test, and a line drawn horizontally from point of intersection gives the excess above outside air that the room air should show.

one to ascertain the proper indoor temperature for plants designed to heat at other minimum temperatures than zero, and any desired temperature indoors. The tables, on the other hand, are based on warming the interior to 70 degrees when the temperature outdoors is zero, and for other specifications other tables would be necessary.

The way to use the accompanying chart, the interesting derivation of which is omitted, is as follows: It will be noted that it consists of two sets of diagonal lines and one set of horizontal lines. The diagonal lines pitching from the right to the left

correspond to the ratio of temperature differences. (The minimum outside temperature under which the system is to operate is subtracted from the indoor temperature that is desired. This difference is divided by the difference between the temperature which the steam or hot water is to have and the indoor temperature.) The other set of diagonal lines pitching from the left to the right corresponds with the difference between the temperature in the radiators at the time of the test and the outside temperature at the time of the test. The horizontal lines give the number of degrees above outside temperature that the room should be at the time of the test.

Suppose the steam plant is to warm a building to 70 degrees when it is minus 10 degrees outside. With steam at 5 pounds pressure, the ratio of temperature difference is equal to $70 - (-10) \div (227 - 70) = 0.51$, 227 being the temperature of steam at 5 pounds pressure. Suppose at the time of the test the steam pressure is 4 pounds, or at a temperature of 224.5 degrees, and that the outside temperature is 10 degrees above zero. The difference between the steam temperature and the outdoor temperature is 214.5. We therefore trace along a diagonal line corresponding to 0.51 and note where it intersects the diagonal line corresponding to 214.5. When reading horizontally from the point of intersection of the diagonals, it is noted that the temperature is 72 degrees. This, as stated, represents the number of degrees between indoor and outdoor temperature at the time of the test, and as this is 10 degrees the temperature of the room should be 82.

Mr. Blackmore: This is a very interesting paper, and must be so to any one who has had anything to do with the construction of heating plants. Since Professor Kinealy formulated a similar rule some years ago I have felt the trade ought to take up the idea a great deal more than they have, and I feel now the time has come when the heating engineers or those installing heating plants should adopt something of this description in their specifications instead of using the ordinary form and follow that (by an equivalent and state the equivalent). I believe this table by Professor Allen at or below 40 degrees is near enough for all practical purposes. Wind velocities are important factors, and I believe a move should be made in that direction, so as to familiarize the public with the fact that there is

an equivalent to a test in zero weather. I believe this is a practical table that can be adopted by the trade. This Society cannot adopt it, but I think it would be a long step in advance if the contractor would adopt some such equivalent in his specifications.

Mr. J. D. Hoffman: I believe the results by Professor Allen, as taken from experiments, will be found a little bit higher than results previously found. First, we want to be sure that the results of these tests are correct, then with this point settled we are in a position to adopt the table and the rate of transmission used to produce the table.

Mr. Berry: I believe Mr. Blackmore is correct in taking the position that the standard for testing heating plants should be established by this Society, at outside temperatures higher than zero; and manufacturers of heating plants would welcome a standard providing for outside temperatures at least as high as 25 degrees above zero.

A standard of this character can be referred to by manufacturers and contractors generally in their contracts, and would educate the consumer to the fact that it was possible to test the heating apparatus when outside temperatures were above zero, and thus make it unnecessary for the manufacturer or contractor to wait several seasons for zero weather conditions before a settlement was made or the guarantee bond cancelled.

Mr. C. B. Thompson: I have seen some experiments in regard to running high temperatures in summer, and we carried the same through zero weather perfectly satisfactorily. The steam being on all night, the room would stand at 70 and never below 68. That was summer time, and a peculiar thing was the length of time it required to raise the temperature. I saw the radiator run for eight hours, and the temperature was rising all the time. We never got anything like as high as this table, 105 running eight hours. There is nothing on which to formulate exact rules, because we haven't gone far enough—just far enough to point out to me if these cases of high temperatures shown by the tables were taken and the contractor were held to them, he would be in a worse box than he is today.

Mr. G. D. Hoffman: Some years ago I made a contract with a man and guaranteed to heat his house when the thermometer

registered 10 degrees below zero. The work was completed, and he was requested to settle, but refused, claiming that the bill was not due until the temperature outside registered 10 below zero and the house was satisfactorily warmed under those conditions. Unfortunately for me we had no 10 degrees below zero weather during that winter, and it was the latter part of December of the year following before the temperature reached that point.

The first night it was 10 degrees below zero we went to this man's house at 12 o'clock, routed him out of bed, and told him we had come to test his heating apparatus and prove to him that it would heat his house when the temperature was 10 degrees below zero. He was very much wrought up, but acknowledged our rights under the circumstances, and told us that he would waive the test and would be down the next day and settle.

After this experience I always arrange my guarantee clause to read " to heat the house during coldest winter weather."

Mr. Blackmore: I would not advise taking above 60. I remember when the matter was brought up a few years ago we decided that an outside temperature of 40 was as high as a test could be made for satisfactory results. I have made experiments in the summer time and never was able to reach the temperatures mentioned here. I didn't continue them long enough, however, to get accurate data. Mr. Allen may have taken too high a temperature, but we ought to make a start. If we limit ourselves to 40 we can always get at or below that temperature. We want to get people accustomed to the idea that there is an equivalent to a test in zero weather. Frequently there are men who hold back till the weather gets to zero. We ought to make a start. Let us be safe and get some standard that will enable the contractor to get paid and not have to wait until a given outside temperature is reached.

Mr. Cary: There are two factors affecting the transmission of heat through radiator surfaces, and I do not learn from this paper that they have been taken into account. The first is that when a considerable amount of air collects inside the radiator and clings to the inner surface of the radiator the transmission is less. In other words, the air distributes itself as a film over the inner surface of the radiator and acts as an insulator.

The second factor is the action of the air against the outer

surface of the radiator. We know that a radiator placed in a still room will not transmit as much heat as when it is placed in the path of a blast. Taking the fan blast apparatus, we have a much greater amount of heat transmitted per square foot of radiating surface than we do when the radiator is placed in still atmosphere.

Professor Kent: An important fact that the paper confirms what has been written by others upon the subject, that the coefficient of radiation per square foot is not a constant quantity, but that the greater the difference of temperature the greater is the coefficient. Thus in the two-column radiator the coefficient increases from 1.71 to 2.26 as the difference of temperature increases from 110 to 260 degrees.

In steam boilers the rate of transmission of heat does not vary directly as the difference in temperature between two surfaces, but probably more nearly as the square of that difference.

CXCIV.

TOPICAL DISCUSSIONS.

TOPIC NO. I.

"Rules in Furnace Heating."

DISCUSSION.

Mr. Chew: The question has been propounded, Is there any advantage in running a pipe on a gradual ascent over running a pipe straight up first and then running it horizontally? The general impression is it is better to run it on a gradual ascent instead of running it up and across.

Mr. C. B. Thompson: I want to ask why galvanized iron pipe is a better conductor than tin pipe.

Mr. Jones: The reason galvanized iron pipe is not as good as a tin pipe for a conductor of warm air is because when made of iron it absorbs heat more readily than tin, and radiates this heat while tin reflects the heat and does not radiate it as does galvanized iron pipe. Iron is a conductor, while tin is a reflector and reflects the heat. When galvanized pipes are used for conveying warm air when the air reaches a certain temperature the galvanizing peels off. This is objectionable. Galvanized iron pipes will throw off heat in the cellar, while tin pipe would conduct it and get it to the point where it is needed.

Mr. Davis: My understanding of a pipe to conduct warm air is, the less heat it throws off the better. This is the first time I ever heard there was objection to it.

It is a well-established fact that tin warm-air pipes are used and recommended by fully 99 per cent. of the furnace dealers and a majority of the furnace manufacturers. Those installing boilers, etc., where the fan system is used require the warm-air conductors made of galvanized iron, but is not this because of the fact that these conductors are so large? It is my opinion that the reason galvanized iron is used for conducting warm air

is on account of the size of the pipe and the necessity of having something stiffer or more rigid than tin.

Mr. Oldacre: I have used galvanized iron for furnace work and had as good results as with tin. It is more durable and lasts longer. So far as the peeling of the galvanizing from the iron is concerned, I have never seen it occur except where the furnace was too small and had to be superheated to accomplish any work at all. And where that is the case, the same thing would occur to the tin pipe. I should not object to galvanized iron for the conveyance of air.

Mr. Davis: My own opinion is tin for conveying air is used to a greater extent from the fact that it is much cheaper.

Mr. J. D. Hoffman: The point was mentioned concerning the loss of heat from the two metals. I cannot now say how much difference there would be, but assuming there is a difference, such pipes are supposed to be covered with some insulating material, and are not to be left exposed. Further, the transmission of heat through ordinary pipe from a hot-air furnace is often not a great factor, especially where the air around it is fairly warm.

One reason why tin is used, is that it is so much smoother on the inside. Even this may affect the transmission of air a little. We all know that every possible advantage should be given to the easy transmission of the air, the motive force being so slight.

Mr. Chew: "Rules in Furnace Heating" was a topic of my own. The statement was made before a large number of furnace manufacturers that the trouble with furnace heating was because there were no rules. Now, I hope this meeting will at least give some one rule for arriving at the size of pipe for heating some given room. I know positively that the statement that there are no rules is absolutely wrong. This Society should be able to say "Here are rules for warm-air heating, indirect steam and hot-water heating, for blower system," etc. At the present time there is a movement to help the furnace men, and it is important for the Society to show that there are rules instead of letting the statement go unchallenged.

Mr. J. D. Hoffman: There are rules covering every particular.

Mr. Macon: I would like to ask Mr. Jones about velocities.

Mr. Jones: My experience is that 100 feet per minute is the

greatest velocity that can be obtained through a warm-air pipe at an elevation of 1 inch in 12 inches where the air supplied is sufficient. I have never tested an absolutely horizontal pipe, but it would be my opinion that the velocity would be much less than where the warm-air conductor had an elevation of 1 inch in 12.

TOPIC NO. 2.

"The Effect of Increased Pressure in Hot-Water Heating Systems."

DISCUSSION.

The Secretary read the following extracts from letters which he had received:

May 30, 1908.

"Enclosed please find a subject that I would like to have discussed. I do not think much of the claims made for heat generators, and would like to hear what other heating engineers think of them. I have put in a number of them and put in plants exactly like them and left the generator off, and can see no difference in the results."

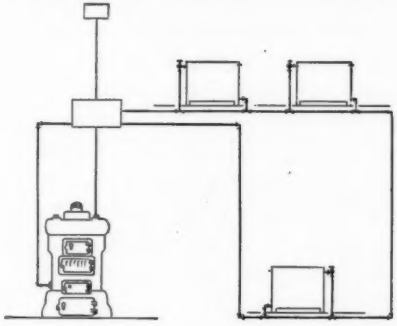
June 10, 1908.

"Regarding the claims made for heat generators and similar contrivances, the philosophy of their theory did not appeal to me as being true. I had no means of testing the flow of water in the pipes to see whether at the same temperatures it would travel faster in the pipes than a plant installed in the same way without the heat generator. I put in a plant and left the heat generator off, and let it run for a month or more, and then put the heat generator on and I could see no difference in the results."

Mr. Donnelly: I saw a hot-water plant some time ago, a description of which would come under this topic.

The radiators were most of them located 100 to 150 feet from the heater, and a 2-inch circuit main was used to supply them. This main was not very well graded, as it was said that this was not necessary with the system that was used, and in some places it dropped to the floor and rose again to supply a radiator as shown in the accompanying sketch. The size of pipe and amount of radiation used in this, as in other cases with this system of circulation, was such that the circulation would not be obtained until the water was heated to a very high tempera-

ture. On the day when I saw it the temperature was about 50 degrees outside, and the temperature shown by a thermometer in the supply pipe was 230 degrees. The temperature in the



return after being re-heated by steam that was produced in the heater, was 130 degrees. Therefore, the normal temperature of the return would be about 115 degrees, thus giving 115 degrees difference in temperature between the supply and return main.

The statement was made that this plant had a very rapid circulation, but I thought that the circulation was extremely slow, and I would like to have the opinion of some of our members upon it. I consider the system as illustrated as having a very slow circulation and believe that the proper test for rapidity of circulation as well as efficiency of circulation is the difference in temperature between the flow and return. I think that the best results are produced when the difference is 20 degrees, rather than 100 degrees or more.

Mr. G. D. Hoffman: Some time ago I was experimenting with a little device for controlling the expansion of water, thereby bringing it under pressure as its temperature increased. About this time I met Professor Woodbridge of the Massachusetts Institute of Technology, and after explaining the operation of the device to him, I asked him if we could, by the use of such a device, accelerate the circulation of the water. In reply he asked me what caused water to circulate. I said "Difference in weight between the flow and return," and then the professor said "That is the whole answer to your question." Pressure has no effect on circulation. The two columns, *i.e.*, the flow

and return must be out of the balance to promote circulation in ordinary gravity jobs. The greater the difference in the weight of these two columns, the more rapid the circulation.

Secretary Mackay: My experience in connection with hot-water heating is that anything that will increase the temperature of the water will increase the temperature of escaping gases and rob the system of any claim made for it of economy. Low pressure steam apparatus would be more desirable than a hot-water apparatus that had any means of increasing the temperature of the water by increasing the pressure. I have tried special systems of different kinds to increase the pressure, and I find I can get as good results with greater economy of fuel and less danger from apparatus not under pressure than with a weight on the expansion tank.

Mr. J. D. Hoffman: If you increase the temperature of the water you must increase the temperature of the gases proportionately to obtain the same amount of heat transmitted in a given time, since the rate of transmission depends upon the difference of temperature between the water and the gases, other things being equal.

TOPIC NO. 4.

"Air Washers, Their Construction and Effect."

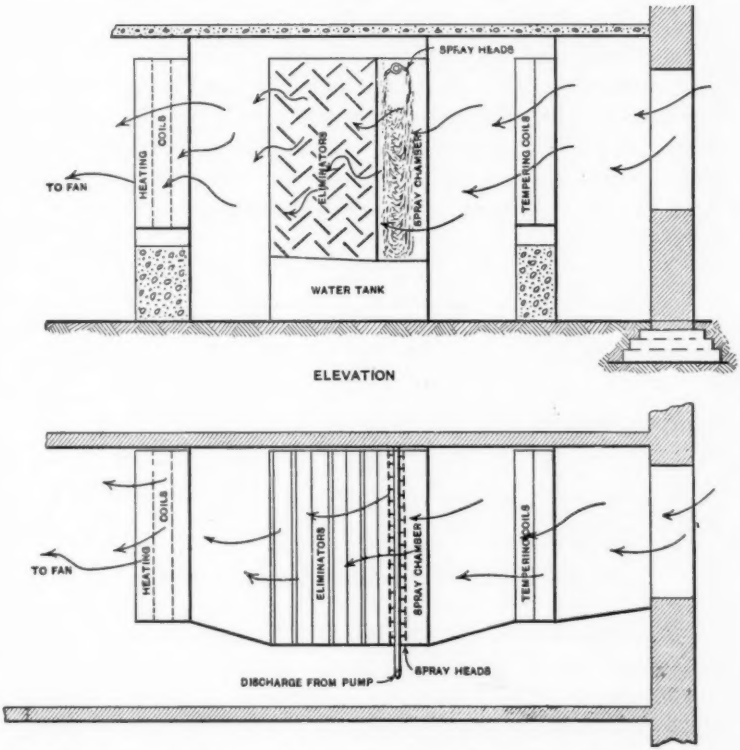
DISCUSSION.

Mr. Kauffman: In the last few months I have given a great deal of study to air washers and purifiers on account of their use becoming general in our part of the country (St. Louis. This is partly due to the extensive use of bituminous coal, which heavily ladens the atmosphere with soot and dirt, and partly on account of the general demand for pure air.

The board of education of our city has given particular attention to this subject, and has now installed in the schools of our city about thirty air washers and purifiers.

Before coming to this meeting, I had occasion to inspect quite a number of the different makes of air purifiers now on the market, and I will show you these by illustration. I might say, however, that all of the so-called patented washers or purifiers are operated on practically the same principle, although the designs may be radically different.

They all use a patented spray head of some sort, some having a rain effect, others making a sheet of water, and others atomizing the water and forming a mist. They all use a series of baffle plates, or eliminators to separate the moisture from the air after it has passed through the water. Some have the baffles



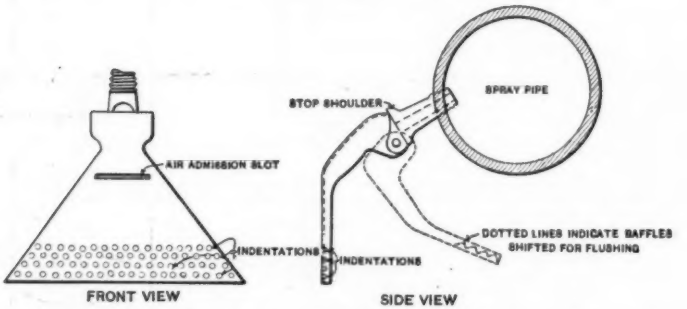
MR. KAUFFMAN'S SKETCH, TYPE A, PLAN AND ELEVATION OF AIR PURIFIER.

in a horizontal position, and others in a vertical position; all of them, however, are arranged in such a manner that no air can get into the fan without coming into contact with some of the plates and eliminate the moisture that is suspended in the air, or possibly large particles of dust or dirt may have passed through the water.

In air purifier A, the eliminators are placed in a horizontal position and in such a manner that when the air comes in con-

tact with them it is first deflected downward, then upward and downward again, etc. The first or down deflector is straight and the up deflector has a gutter or groove to carry off the water from both the down and up deflector plates. This arrangement is repeated in the successive plates as illustrated; the water is brought to a gutter at the side of the housing of the eliminators, then brought down to the sump or tank, and then sucked into the centrifugal pump and used over again in the spray heads.

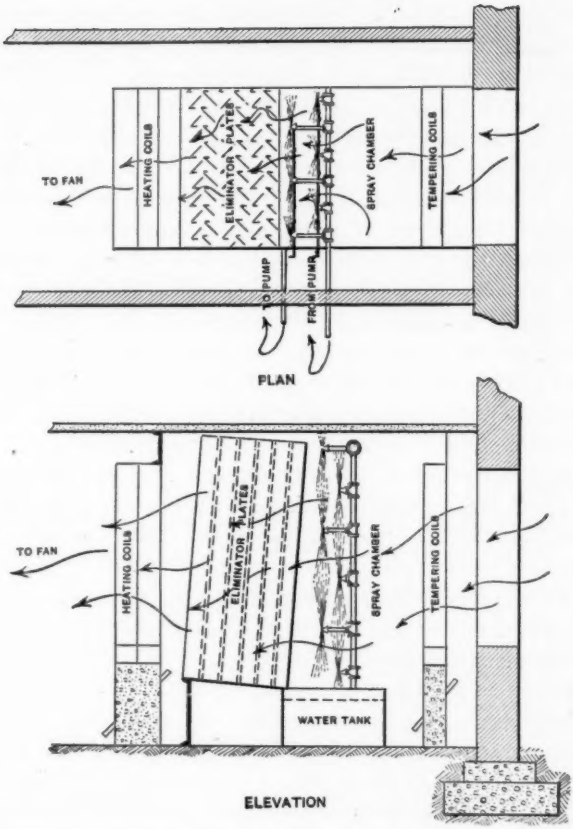
The spray heads for this washer are arranged in such a manner as to form a solid sheet, having the effect of rain dropping down in two solid sheets about one foot apart. Between these sheets there is a mist formed, which has a great cooling effect upon the air, after passing through the sheet of rain.



Mr. Kauffman's Sketch, Spray Head of Purifier A.

You will see how this rain effect is brought about by reference to the detail of the spray head. The water comes out in a solid stream, hits a baffle plate and is spread out and then sent through a series of indentations staggered on the plates, which form the rain effect in very fine drops, making practically a solid sheet.

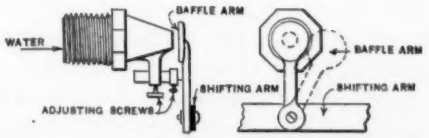
In Type B, the eliminators are placed practically vertical, and in such a manner that, when the air comes in contact with the first plate, part of the moisture or foreign matter is eliminated by the plate and hook on the end of the plate, then sent across to the next plate, which is staggered, but has the hook on the other end of the plate. It then catches the air again and throws it to the next plate, and so on. When the air has passed through all the plates, it is entirely free of moisture or foreign matter.



Mr. Kauffman's Sketch, Type B Plan and Elevation of Air Purifier.

The water flows down these plates to the bottom, then into the water tank, and is again used in the same manner as described for purifier A.

The spray heads for Type B are entirely different from those



Mr. Kauffman's Sketch, Spray Head of Purifier B.

in use on Type A. The water comes out of the Type B spray head in a stream and is baffled in front of the opening, forming a sheet of water probably 2 feet in diameter. These heads are so arranged by a series of pipe work that they are staggered and no air can pass through them without being washed or coming into contact with the water before going to the eliminator.

The baffles are arranged in a series on a shifting arm so that a number of heads can be flushed out at the same time.

The objection I have found to this type of baffle-shifting device is that when you want to use it is likely to be all rusted, and if in that condition cannot be budged.

The flushing of this type of head I have found is a very important matter, as the heads get clogged up with dirt between the outlet and the baffle all the time, and require very frequent attention in order to keep the head working perfectly.

I recall a prominent installation that I have seen where there were 48 of these sprays in this type of washer, and out of the 48 there was not one working perfectly. With the pump working as hard as it could, there were probably two or three heads that had a little water spurting out of the side, but they were not working nearly the way they should, and the rest of them were completely clogged up.

This sort of conditon, of course, is partly due to the person in charge of the apparatus and partly due to trouble with some shifting device, which will invariably rust up at the screw joints with the baffle on the spray head and shifting arm, as illustrated.

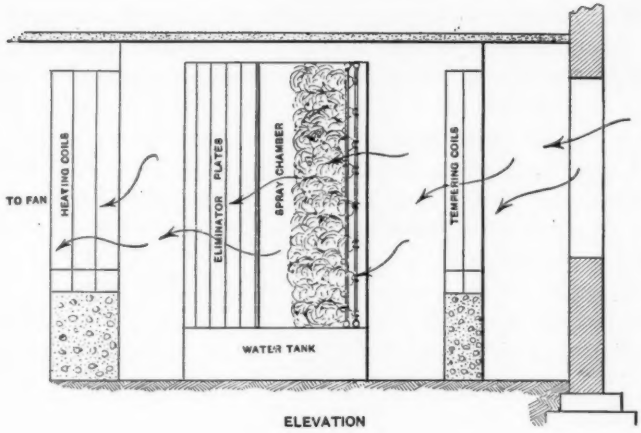
The head itself is as perfect in its operation as can be, and I think that this type of spraying is very good, but there should be some other manner of flushing the heads than the one that is in use, as it is very troublesome.

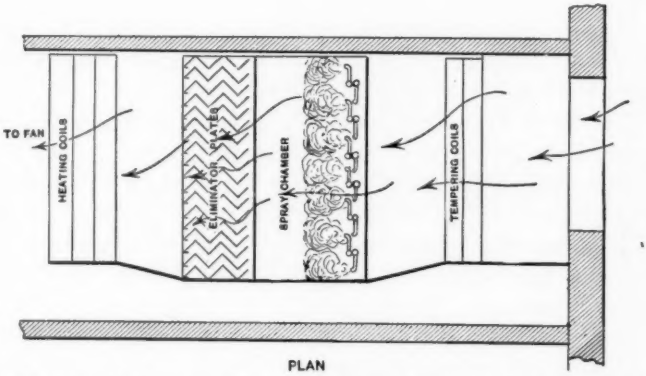
Type C is entirely different in some respects from either one of the purifiers described before, that is, as far as the spraying device is concerned.

The sprays used here produced an entirely different spray than either Types A or B; they are arranged on a series of pipe work and are staggered in such a manner as to throw a spray about one foot in diameter.

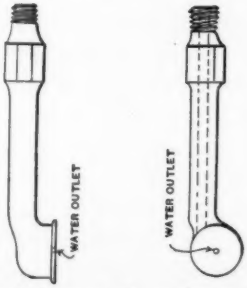
The spray produced by this head is practically a mist which undoubtedly produces a great cooling effect on the air.

By reference to the detail of this spray head, it will be seen





MR. KAUFFMAN'S SKETCH, TYPE C PLAN AND ELEVATION OF AIR PURIFIER.



MR. KAUFFMAN'S SKETCH, SPRAY HEAD OF PURIFIER C.

that the water is thrown around in the head similar to the effect created by a cyclone dust collector. A whirling motion of the water is produced and discharged through a hole about 3-32 inch in diameter. It then spreads out in a mist varying from about the diameter just stated to 12 to 14 inches.

I have found also that these heads clog up with dirt very rapidly, and require close attention, although the manufacturer of this purifier has taken every precaution to prevent any dirt getting into the heads.

As to the eliminators used in this type of purifier, they are arranged in a vertical position, as illustrated, and each one is continuous from front to rear, the rear two or three having projections on them to catch any moisture that may have passed the first set.

The water is handled in this one similar to that of the others previously described.

Type D sprays are similar to those of Type B, but the velocity of the air through the water is very much greater than that through the water in Type C, just described.

The air in Type D is supposed to pass over the water three times, as you will note by the illustration.

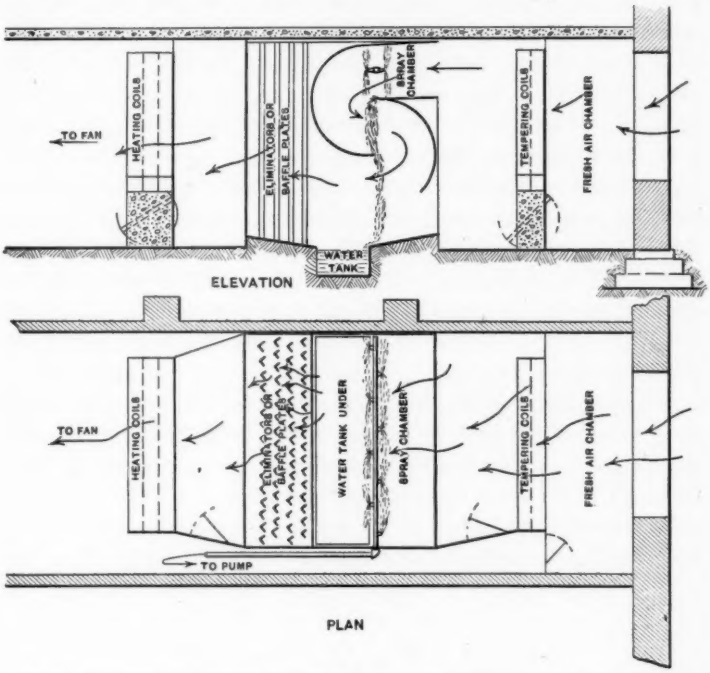
The water forms a perfect spray at the spray heads, in the top chamber, but as the water drops down by gravity to the lower chamber, the spray is not perfect, and the air has a chance to go through the open spots in this sheet of water and thereby not be washed.

The same thing occurs in the next chamber or sheet. There are still larger holes in this sheet for the air to pass through and neither one of these sheets is perfect, from my observation, and the air is only washed once in this type instead of three times, and then at a high velocity, which is a very bad fault.

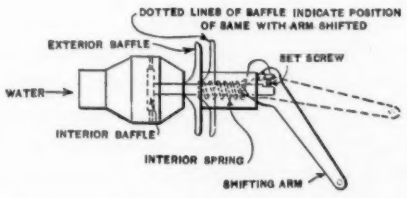
The baffles of this type are set in a vertical position as illustrated. By reference to the detail of the spray head for this type of purifier, it is seen that it is somewhat similar to that of Type B, inasmuch as the water is baffled as it leaves the opening in the nozzle and forms a spray about 3 feet in diameter.

The water is baffled first on the inside of the head, and then at the opening of the nozzle again. I have found that this nozzle also clogs up at the openings and must have very frequent

attention to keep it cleaned. The great fault that I have found with it is that when you want to operate the lever handle to open the head, it is also rusted at the screw joints and cannot



Mr. Kauffman's Sketch, Type D Plan and Elevation of Air Purifier.



Mr. Kauffman's Sketch, Spray Head Purifier D.

be moved, and requires a lot of time to get it in operation so that you can clean the head.

All of the eliminator or baffle plates on all of the different types of purifiers seem to work perfectly in eliminating the moist-

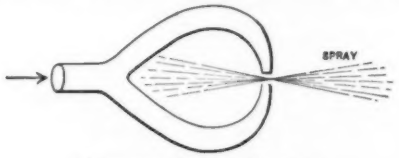
ure that is suspended in the air, but the main fault seems to lie in the spray heads in keeping them clean and in operation.

If the spray heads are not in operation, you might just as well have no washer at all, as these heads are the most important and the heart of the entire apparatus.

As stated before, all of the purifiers recirculate the water by collecting it in a tank and then drawing it through screens to take out as much solid matter as possible. The water then flows into a centrifugal pump, either operated by an independent motor or belted off the fan shaft. The water is discharged thence back into the spray heads, and there may be some dirt of some sort in this water, which lodges in the head and clogs it up.

All of the purifiers, as far as I can see, have taken out the amount of foreign matter that they guarantee, and also cool the air as they guarantee. Of course this is only true when the humidity is not too high. It must not exceed 72 per cent. to accomplish the cooling guarantee, otherwise I do not think that the guarantee can be lived up to on this point, unless refrigeration is used to accomplish it. All of this, of course, is done when all of the spray heads are in operation.

Professor Kent: Here is a sketch of a spray nozzle. The water going through the one nozzle meets the water from the



PROFESSOR KENT'S SKETCH.

other, at high pressure, and as the energy has to be expended somehow, it makes a spray that spreads out like a fan. It is said to make a very fine spray. The nozzle may be so placed in the washing box as to cause the sheet of spray to be at right angles to the direction of the air current.

TOPIC NO. 5.

The Effect of Air Leakage Around Windows on Heating Apparatus.

DISCUSSION.

Secretary Mackay: Unfortunately a paper received on this subject came in too late for the Publication Committee to em-

body it among the other papers. It gives results along the same lines described by the author, Mr. Whitten, at our last annual meeting. I understand it is Mr. Whitten's intention to give us further results of tests at our next annual meeting.

Mr. Whitten: What the Secretary has said is correct. The data given at the last meeting were figures obtained by experimenting with a blower on various sashes to determine comparative leakage. What we have tried to do this time and have partly accomplished is to see just what heat losses were caused by these leakages. We built a box of about 80 cubic feet capacity with a window frame 2 feet by 4 feet in one side of it, which was bolted on tightly. The first test was to measure the leakage through a hole placed opposite the window. The box was placed on the top of a high building where the wind had free scope.

The accompanying table shows the relative leakage with an ordinary sash and one equipped with metal weather strip:

AIR LEAKAGE THROUGH ORDINARY AND METAL-STRIPPED WINDOWS.

Feet per minute 4-in. anemometer.	Feet per minute in opening in door of box 2½-in. anemometer.	
Top of box.	Metal stripped sash.	Ordinary sash.
700	12	180
550	20	247
800	32	386
840	36	410
835	22	388

The apparent inconsistencies in this table are due to shifting of wind, but the average differences seem to be sustained.

We then placed in the box an electric radiator of 800 watts capacity, plugged up the hole opposite the window and turned on the current. When the temperature of the interior reached 82 degrees we shut off the current and removed the plug from the hole to allow the leakage of the window free access. When the temperature reached 70 degrees the current was again turned on and the plug still left out, allowing natural leakage free circulation.

The sash was then changed for one having a metal weather strip applied and the same process gone through. A great many

tests were made along these lines, two of which are illustrated by the curves, Figs. 1 and 2.

In another case with weather-stripped sash the temperature ran from 72 to 80 degrees in 18 minutes and back to 72 degrees in 40 minutes. Many tests were made, of which above are typical samples. I intend to make some more tests in December next, when I hope to get lower outside temperatures.

One thing I did in connection with the box was to place a tight shutter on the window and observe how long it took to heat the interior and to lose the same. I then took the shutter off, and with a tight sash, repeated the process. On account

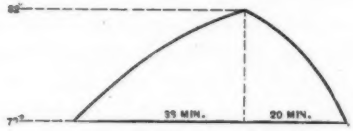


FIG. 1.—ORDINARY SASH, 2 X 4 FEET, 1/16-INCH CLEARANCE.

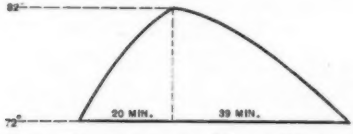


FIG. 2.—SASH EQUIPPED WITH METAL WEATHER STRIP.

Outside temperature, 33½ to 34; wind velocity, 3¾ to 4 miles per hour, blowing directly on sash; electric radiator, 800 watts capacity; average current, 114 volts.

of the small difference between inside and outside temperature it was not possible to get a definite line on the actual glass loss. The results were indicative, however, and showed that glass loss in still air is much smaller than usually given credit for.

Mr. C. B. Thompson: Did the losses closely conform to what are known as the German coefficients of heat losses?

Mr. Whitten: Yes, they did; that is, with the Austrian coefficients.

Mr. C. B. Thompson: What is known as the German coefficient of heat losses for buildings is used and accepted as standard all over the Continent of Europe. Peclet, the French physicist, did more laboratory work along these lines than anyone else, but Professor Rietschel has taken Peclet's coefficients

and tried them out on a larger scale. The German coefficient for glass has nothing whatever to do with the way the sash is fitted to the frame and, when you come to think of it, it would be impossible to give a coefficient for the glass and the leakage about the sash because one sash might be ¼ inch away from the frame, while the next one would be tightly fitted as you describe.

If this Society can get together sufficient data to establish a set of standards for the guidance of heating engineers, architects and owners, it will have accomplished a great work. With an accepted set of standards, a heating engineer who installed work in accordance with such standards could collect his pay and not wait, as he now has to, until cold weather to test the apparatus before he can get a final settlement. In Germany all that is asked of the heating engineer is to install the heating apparatus according to Rietschel's formulæ. Then, if the heating apparatus does not heat, the builder is called upon to make good. The German engineers, however, do not take the German coefficients literally, but each man adapts them to his own particular practice.

Mr. Whitten: The United States Government, in some cases, has reduced its radiation on information I have given its engineers on this matter.

TOPIC NO. 6.

"The Proportion of Radiator Surface and Method of Ventilating Rooms for the Drying of Macaroni."

DISCUSSION.

Mr. Hale: Two weeks ago I had a talk with the President of the American Association of Macaroni and Spaghetti Manufacturers who asked if there was any approved method or rule governing the construction of rooms and steam apparatus for the proper and satisfactory drying of macaroni.

He stated that he had been in business a number of years, and was still looking for a more perfect way of getting results. In the South the drying is done in open air, but this method takes too long, and where the drying is done inside the building the proper ventilation of the room seems to be a problem that has not been satisfactorily solved.

XUM

The macaroni or spaghetti is hung on racks, and it has been found that the drying must be done evenly and without draughts, in order to prevent the product from breaking and dropping to the floor. In sending in the question it was my desire to get from the members any enlightenment on the subject, as I have had no experience in this particular line.

Mr. Weinshank: I never dried macaroni, but if the amount of moisture in the raw product is a fixed quantity, then a very good method can be applied, so that the drying would be continuous. A product similar to macaroni, namely, curd, is being dried in the West by a continuous method very successfully. The only difference between the curd and the macaroni is that the curd was dried to such a state that it was ready for the grinder, whereas I understand macaroni must retain a certain amount of moisture. This, however, should not change the condition, and some continuous method could be devised.

It is my opinion that if the amount of moisture in the raw product and the amount of moisture in the finished product is a fixed quantity, then the number of cubic feet of air required to dry that material also the amount of heat required is very easily determined.

Secretary Mackay: Macaroni has to remain stationary. The method in use is to have it stationary. It seems to me any movement would not accomplish what he was after, but would break the macaroni.

Mr. Hale: This gentleman is President of the Macaroni and Spaghetti Manufacturers' Association, who had discussed the question of drying at their annual meeting held at Niagara Falls, N. Y., during the week of July 7th, but that none of the members had been able to shed any light on the subject. Most all of their members stated that their apparatus was more or less crude and not as satisfactory as they would like. The Society should assist the macaroni manufacturers, and I would suggest that a committee be appointed to gather data and report at a later date to the Society as to the result of their inquiry. I was asked if there was any method that would dry macaroni in a day instead of six days.

Mr. Kauffman: I know of a macaroni manufacturer in St. Louis who has quite a large place—sixty by two hundred feet. On the second floor of the building is done the drying, and he

pushes the rack containing the stuff from one room to another and keeps it in so many hours, and so on down until it is properly dried.

President Mackay: How long to go through?

Mr. Kauffman: I think about two days.

Mr. J. A. Donnelly: Seven or eight years ago I took a contract to heat a macaroni factory, a fairly good size, eight-story building, and square, an addition to the present works.

The difficulty is not in the drying of macaroni, but in the curing of it. Macaroni is made from a special winter wheat. They are very careful in getting some special grain, special growth, and unless cured very carefully the outside is dried first and if it does it is full of tiny cracks and useless, and they cannot handle it after taken down. It is expensive stuff to make, but they have no trouble if everything goes smoothly.

I would not recommend treatment with air-washers. If you get too much humidity, it gets pasty on the outside. Some time afterwards a party that took a contract to cure it was reckless enough to put a dryer in the basement and built racks, and it was festooned on these racks, but they were never able to get complete enough circulation of air to get uniform drying, for some would be dry and others would mold, and if not properly cured it cracks.

At present this concern is drying macaroni by having direct radiation on the side walls, not under the windows, and they put the macaroni in there and shut up the room tight, and gradually let in air through the windows. It takes an Italian who can speak three languages to ventilate these rooms right.

You should hire an Italian who had taken a course at a correspondence school and can speak three languages and then do it by day's work.

Mr. Weinshank: From what I have heard I do not see much difference between curing or drying macaroni and drying glue. I have been successful in drying glue, which is a very delicate material, and if not treated properly will be ruined. I do not see why macaroni cannot be cured in the manner described by Mr. Kauffman, on racks and passing through various stages of temperatures.

Mr. J. A. Donnelly: If the Committee on Data on Fan Blast Heating wants some original data on drying glue, there is a

plant, erected forty or fifty years ago, in Long Island City, and they are drying glue there with a wooden fan, wooden blades and arms, twenty to twenty-two feet in diameter. The works are in Long Island City, and has one of the oldest fan installations in the country—a very large fan.

Mr. Hale: The gentleman I talked with stated that he had tried the blast system, but had not been able to get very good results. The present method requires about six days to dry or cure the macaroni, and his desire was to determine some method by which the drying could be done in a day or two instead of six.

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